A MODEL OF SOCIETY TO USE IN SYSTEMATIC ANALYSIS AND MANAGEMENT PLANNING FOR SOCIETIES UNDER STRESS

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with an Appendix by
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November 1969

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Summary

A MODEL OF SOCIETY TO USE IN
SYSTEMATIC ANALYSIS AND MANAGEMENT PLANNING
FOR SOCIETIES UNDER STRESS

The purpose of this research effort was to develop a model of society that would permit the incorporation of social and psychological factors in systems analysis of society in crisis, to identify key social and psychological factors that influence the functioning of society in crisis, to develop quantitative estimates of the values of some of these key social and psychological factors, and to show how the model permits the incorporation of key social and psychological factors into estimates of societal vulnerability and system functioning.

A conceptual model of society has been developed. The basic constructs of society, People, Institutions, and Resources, are set in a structural-functional relationship to each other. People are viewed as being differentiated into status groups. Each status group is characterized as having basic life support and personality support needs that are normally easily satisfied, and as having status needs that are precariously satisfied. Precariously satisfied or unsatisfied needs are identified as the basic cause of motivation. People provide the effort that activates the societal system, and effort is the consequence of motivation. A major consequence of motivated effort is occupational role playing, most of which is absorbed in the society's production network. In the production process, resources, including raw materials, capital goods and semi-finished products are utilized to provide goods and services to the marketplace. People's demands on the marketplace are in accordance with their life support and status needs. Satisfaction of demands in the marketplace provides motivational impetus toward systems-supportive role playing by people; dissatisfactions lead to efforts to change the structure of the system. Social change is the consequence of volunteer role playing in the area of Government and Social Action. This is the area where society creates and recreates Institutions (culture) that define the socially approved mode of operation of the organizations that make up society.

There are a number of variable social and psychological factors that influence people's ability and willingness to exert effort in support of the societal system. These include uncertainty about satisfaction of basic life support and personality support needs, utility of money wages in the marketplace, perceived societal stability, and several effects that can be a direct consequence of experience in nuclear attack.

The network of relationships suggested by the model can be represented as a family of equations. These equations allow one to calculate postattack capital productivity, the effort available to be utilized in the production network and in repairing the production network, and the quality of the postattack available effort. With sufficient information about the postattack state of the system elements, it is possible, using the above mentioned equations, to determine the viability of postattack society. The model provides the basis for the development of postattack contingency plans that would allow postattack leaders to suggest distribution of available effort in ways most likely to lead to recovery.

TABLE OF CONTENTS

		Page
SUMMARY		iii
I.	INTRODUCTION	3
	A. Background	3
	B. Objectives	4
	C. Approach	5
	D. Uses of End Products	8
II.	THE NATURE OF THE MODEL	11
	A. Basic Elements and Underlying Sociopsychological Principles	11
	B. Motives and Needs	15
	C. Relationship to Productivity	17
	D. Nature of Status Groups	19
	E. Role of Values and Institutions	21
	F. Relationship of Institutions to Societal Functioning	24
	G. Relationship to Production Network	25
III.	CHARACTERISTICS OF SOCIETY UNDER STRESS	31
	A. General Functioning of the Societal System	31
	B. Functioning of the Societal System under Stress	36
IV.	THE MODEL IN EQUATIONS FORM	43
V.	AN ILLUSTRATIVE EXAMPLE OF USE OF THE EQUATIONS	61
	A. Introduction	61
	B. The Example	63
VI.	CONCLUSIONS	77
APPENDIX A:	AN ILLUSTRATIVE EXAMPLE--REESTABLISHING AN ELECTRICAL POWER GENERATION PRODUCTION LINKAGE IN A METROPOLITAN COMMUNITY	A.1

		Page
A.	The Hypothetical Situation	A.3
B.	Manpower Requirements for Repair of Electric Utility System: The Basic Model	A.5
C.	Variants of the Basic Repair Model: Implications for Labor Productivity of Changes in Work Intensity and Scheduling	A.8
D.	Labor Substitution Analysis for a Critical Skill Constraint: Implications for Labor Productivity	A.11
E.	Summary	A.24
TAB A:	Metropolitan Electric Utility System: Typical Configuration	A.27
TAB B:	Dictionary of Occupational Titles	A.31
APPENDIX B:	ROOTS OF THE MODEL: THE CONCEPTUAL BASIS	B.1
APPENDIX C:	BIBLIOGRAPHY	C.1

A MODEL OF SOCIETY TO USE IN SYSTEMATIC ANALYSIS AND MANAGEMENT PLANNING FOR SOCIETIES UNDER STRESS

I. INTRODUCTION

A. Background

Civil defense thinking has been concerned with understanding and, insofar as possible, planning for avoiding the physical effects of nuclear weapons. Passive defense must begin with saving lives. Protecting the population from the effects of gamma radiation has had high priority, and thus is at the core of present passive defense planning.

The research and dialogue generated by the Office of Civil Defense over the years have been heavily committed to determining shelter requirements, developing shelter capabilities, stocking shelter spaces and developing plans for getting people to shelters in the event of an attack. These projects have probably progressed farther than those who are closest to them realize. Some tentative contingency plans do exist for managing localities through attack readiness and transattack survival phases of nuclear war.

Paralleling this primary research and development effort has been a concern about reconstituting society when people emerge from shelter after an attack. This has produced tentative answers to such questions as how many people might survive each type of attack, what the social composition of the survivors might be, and what capital goods might be available for use by survivors.

In recent years, estimates of national survival and recoverability have been developed in the framework of input-output analysis. The damage to the productive capacity of the economy has been estimated, factor by factor, for particular attacks. Using alternative factor utilization possibilities, an input-output framework, and linear programming, estimates of maximum postattack production possibilities have been developed. These estimates have generally suggested that postattack economic survival is achievable.

Among the participants in the civil defense dialogue, an awareness has developed of the importance of key social and psychological factors, of their crucial role in societal system functioning, and of the necessity for understanding this role in planning crisis management. There has not been as clear an awareness of how these factors can be taken into account in assessing the consequences of crises for societal functioning or in planning crisis management. Some ideas and tentative plans for dealing with specific aspects of the postattack situation have been developed, but there has been an uncertainty about how these will fit into and affect a total system recovery effort. In short, over the past ten years, civil defense research has generated a substantial body of information on the kinds of problems which will be encountered in a postattack situation, but has not yet proposed a systematic solution. There has been no systems model to integrate available information and to identify critical areas where information is inadequate. No base has been created for incorporating social and psychological factors as well as physical effects into a societal model for use in problem definition and organizing management planning in crises. This kind of systems model of society is needed both for these purposes and for use in better defining and organizing solutions to other social problems.

B. Objectives

The first objective of this study was the development of a model of society suitable for use in systems analysis, a model which would (1) identify the essential elements of a viable society and the relationships among them, and (2) facilitate adequate consideration of the social and psychological factors affecting the functioning of the social system these elements and relationships constitute.

The model is thus intended to show how various elements of society are related to and affect each other, and how changes in any particular element can affect the total system. The kinds of changes considered are those that might emerge during situations of intense societal stress, and the ultimate objective of this research effort is to show how the model developed can be used to better analyze crisis situations and to identify more specifically certain problems of system management that arise out of crises. The postattack situation was selected

as one type of crisis situation in which such analysis can be of substantial value, and examples of the model application have been drawn from the postattack situation.

To date, key social and psychological factors have not been adequately considered in analyzing nuclear war crises and their consequences, partially because there has been no methodology appropriate to the task; the model forms a basis for discovering how changes in these factors change societal system functioning and ultimately affect its vulnerability and viability.

C. Approach

The model can be viewed as an analogue of society. Robert Oppenheimer once wrote about the scientific use of analogy as follows:

> Whether or not we talk of discovery or of invention, analogy is inevitable in human thought, because we come to new things in science with what equipment we have, which is how we have learned to think, and above all how we have learned to think about the relatedness of things. We cannot, coming into something new, deal with it except on the basis of the familiar and the old-fashioned. The conservatism of scientific enquiry is not an arbitrary thing; it is the freight with which we operate; it is the only equipment we have. We cannot learn to be surprised or astonished at something unless we have a view of how it ought to be; and that view is almost certainly an analogy. We cannot learn that we have made a mistake unless we can make a mistake; and our mistake is almost always in the form of an analogy to some other piece of experience.[1]

The societal model discussed herein is the product of quite a few years of work that preceded this contract, work toward integrating knowledge about society into a closed system of relationships. To totally delineate every aspect of a societal system is obviously a task of extreme magnitude and complexity; thus this

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[1] Robert Oppenheimer, "Analogy in Science," The American Psychologist, II, No. 3, March 1965.

model is necessarily tentative, but at the same time it is supported by current theory and current data and has much validity as a tool for scientific inquiry on the frontiers of social science.

Its presentation in this report is not as a tool for scientific inquiry, but as a framework for integrating knowledge and hypotheses about society in crisis; the ultimate utilization of this knowledge can serve to develop a family of crisis contingency plans and a related management information system that can be used by leaders of society in crisis to optimize chances for survival and recovery.

The model is a conceptual scheme in which basic societal elements are identified, as are a complex of relationships among its parts. The statements presented in this report concerning these relationships may be considered as hypotheses by the basic research scientist; on the basis of current knowledge, the operational research and development scientist must consider them as working descriptions of structure and function in society.

The model is comparable in form and level of generality to The Twentieth Century Fund's model of "The Flow of Income and Expenditures in the United States."[2] Just as Dr. Dewhurst and his associates at The Twentieth Century Fund could produce a much more complicated and detailed representation of money flow in our society, so the model could contain a much more complicated and detailed representation of relationships among major elements of the societal system; but such detail can obscure the primary relationships of interdependence, hindering a total overview of system relationships. This highly simplified societal systems model is presented as a tool for analysts to use in determining if their analysis is adequately integrated with relevant major systems factors.

The specific concern of the work has been with the effect of crisis-related social and psychological factors on production of goods and services; one goal has been the development of a scheme for demonstrating the impact of these factors.

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[2]Anyone not familiar with this model may obtain a diagrammatic copy by writing to The Twentieth Century Fund, 41 East 76th Street, New York, New York 10021.

In the process of developing linear programming analyses for determining the mix of capital goods for optimum productivity, there is a hidden assumption that the labor to utilize the capital goods is available and at the same level of productivity per hour of utilized capital goods that existed before the crisis. There are good reasons to question this type of assumption. Often in crises some persons with requisite skills are simply not available; some coefficient of reduced productivity must be applied to skill substitutions. Further, motivations and capacity to devote requisite man hours to a job and motivation on the job will be a function of the social and psychological situation of the worker. There is a need to show how these and related factors enter into the determination of productivity. The motivation of workers and the time that they are willing to devote to system support effort is also related to how the system is functioning--some social and psychological factors that affect productivity are thus a function of productivity itself. The search for social and psychological factors that affect productivity works its way around the system and back to productivity itself. The system model is the necessary tool for performing this analysis.

The objectives in this study were not limited to analyses of productivity. Productivity is meaningful only as it satisfies the felt needs of people. We are concerned with the relationship between productivity and the felt needs of the people of the society as one indicator of the adequacy of system functioning. Societal systems exist for people, and comparing productivity (supply) and felt needs (demand[3]) is one means of determining whether the system is serving its purpose. The model allows us to identify the structural-functional form of "demand" and provides a basis for estimating the demand that would reflect felt needs after any specific crisis.

The basic question we asked and attempted to answer in this research was: Under what conditions is a society viable? The concern behind the question is with the requirements for maximizing the chances that, following a crisis, our society

[3]The term "demand" generally refers to the goods and services people actually receive in the marketplace. It is used here to mean the goods and services that people would like to get in the marketplace. This allows us to discuss unfulfilled demand, and this is a useful construct in our analysis.

will be viable. For purposes of this discussion, a societal system is defined as viable when it produces and distributes the goods and services necessary for the survival and social life of its people in such a way as to elicit from its people the support necessary to continue its form and functioning. This implies that viability exists when a sufficient majority of the active people in a society are receiving satisfactions such that they are willing to perform occupational and related volunteer roles at a level sufficient to maintain and sustain the institutions and organizations of the society.

This definition can apply to any society, totalitarian or democratic, equalitarian or competitive. The difference between societies lies in the basic value system as institutionalized in the society. The present mode of defining viability suggests that post-crisis viability of United States society necessarily includes sustaining its present basic values and the basic institutions that manifest these values. Operationally, this society can be defined as viable if it were able to produce and distribute goods and services in such a way as to provide for life support and social life and to receive the support of the large majority of people for a governmental system directly evolved out of the present governmental system.

The model provides indicators of system viability on the basis of (1) an identification of the prevailing relationship of supply and demand and (2) a group-by-group identification of willingness to play institutionally supportive occupational and volunteer roles.

D. Uses of End Products

The basic products of this research are a conceptual model of the societal system, a family of equations that describe the primary relationships among the elements of the model, and a partial listing of social and psychological coefficients that apply to the equations and therefore have significance for system functioning.

The conceptual model of the societal system can serve as a frame of reference for persons writing scenarios about nuclear war crises and about other social problems. As a frame of reference, it reminds the scenario writer to take

each basic system element and system linkage into account in developing the scenario.

The "family of equations" form of the model permits somewhat more refined analysis. It makes it possible for an analyst to assume a particular attack and a particular postattack set of management decisions, to calculate how much useful effort for producing goods and services is available, and to estimate whether or not this effort is sufficient to provide satisfactions for people so that they will continue to sustain this effort. The equations also allow analysts to try different postattack management schemes, particularly schemes for dividing available effort between direct production and repair, as means of reaching recovery goals.

The family of equations does not provide answers as precise as would be desirable, because many of the coefficients used in the equations and many of the hypothesized relationships expressed by the equation are simply educated guesses. This approach does, however, allow the analyst to be explicit about the nature and implications of the guesses he is making, and it provides a means for evaluating the effect of each specific guess on the answers developed.

In the conceptual model and the family of equations, analysis of production of goods and services treats labor as a variable factor of production. Prior analyses treat labor as a factor having some fixed and automatic relationship to capital. Labor is here treated as a potentially scarce production factor in the postattack world. Both the willingness or unwillingness of able-bodied survivors to provide effort (labor) to the production network and the enthusiasm that they bring with them to their labor depend on social and psychological factors. It is through this avenue, primarily, that social and psychological factors are introduced into estimates of societal viability in this form of analysis. The equations specifically make it possible to evaluate the effects of various social and psychological factors on system viability.

The discussion of the model emphasizes the point that society is a network of elements and linkages, and that damage to elements and linkages is significant not only because of the particular loss but also because of the way in which the loss

affects other elements of the system. The conceptual model and the equations provide a framework for a network analysis of society under stress that includes the social and psychological elements and linkages of society.

The equations serve to make specific the kind of management information that is necessary for the management of society under stress and also suggests the kinds of contingency plans that are needed for managing a society after a nuclear attack. The coefficients in the equations must be defined in numerical terms if the equations are to be solved; their determination thus depends on the development of a management information system. The coefficients of the equations suggest what kind of management information system must be developed, preattack, if the management plan is to be implemented postattack.

It is the hope of the model builders that this presentation can be taken and put to use in the various ways discussed above.

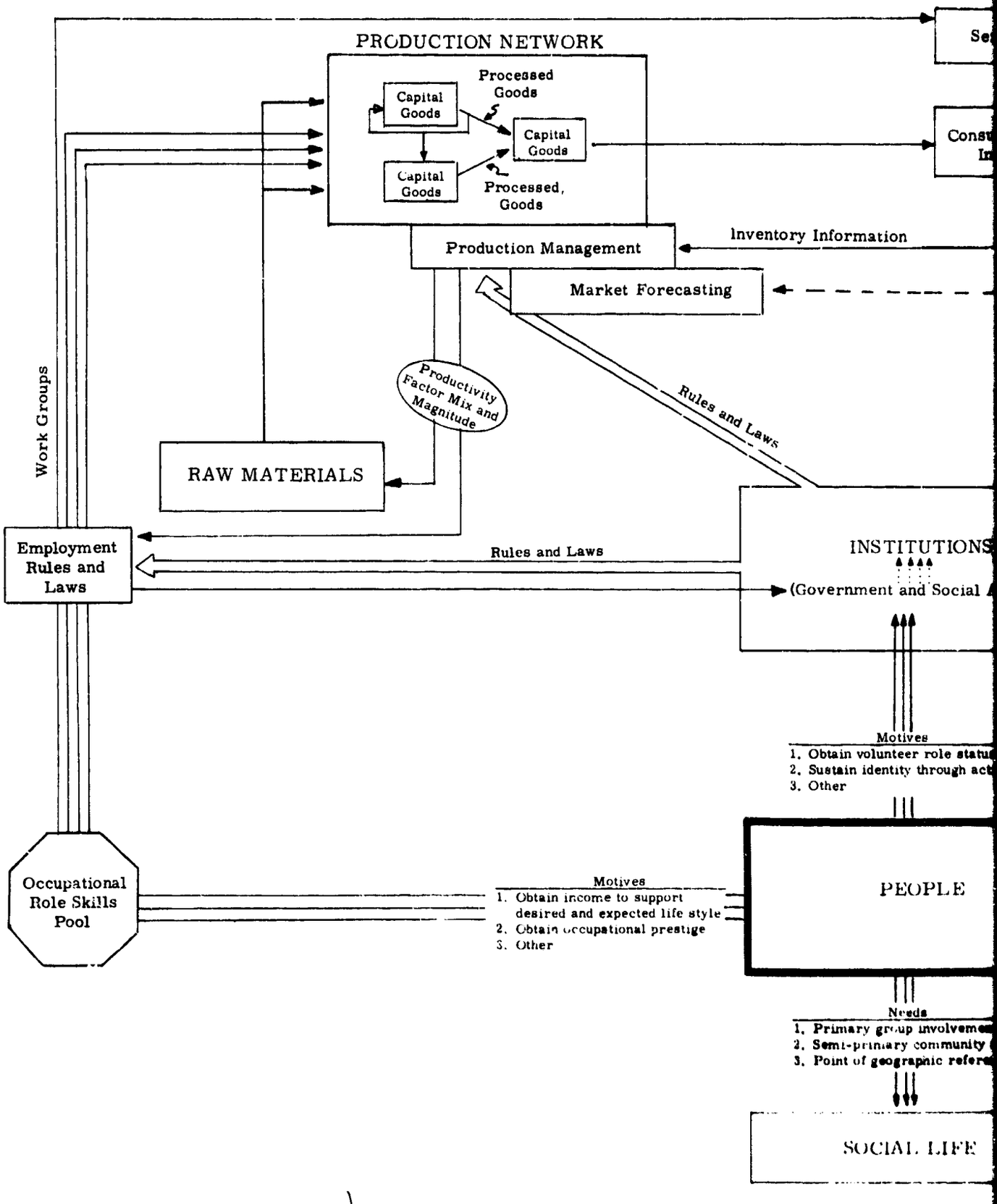
II. THE NATURE OF THE MODEL

A. Basic Elements and Underlying Sociopsychological Principles

This description of the model of society is presented as a discussion of the simplified basic diagram, Figure 1. The major constructs of society--People, Institutions, and Resources--are displayed there in a structural-functional relationship to each other. "People" and what we have defined as "Institutions" are each represented in a separate box in the diagram; "Resources" are distributed in the diagram as Raw Materials, as Capital Goods functioning in the Production Network, as processed goods in this same network, and as a Consumer Goods Inventory. People provide the effort, or human energy, that makes the societal system operate. People's effort is directed into three channels: into their Social Life, into the creation and maintenance of their society's Institutions, and into the Production Network, in terms of both employment and consumption. A variety of different needs and motives affect the nature and amount of effort expended at different times, and Rules and Laws determine the forms of expression effort can take.

Production absorbs a large portion of the effort and converts it into Goods and Services that are made available in the Market. In the Market they are obtained and consumed by People. This consumption of goods and services serves to replenish both the physiological capacity and psychological motivation that become effort for the system. As social and psychological factors affect motivation, they become crucial for societal operation. Social Life provides the outlet for effort to satisfy needs whose satisfaction is, for People, an end in itself.

Effort is the term that represents human energy available for use in society. Effort is directed into the societal system through occupational role playing and volunteer role playing of people. Role-playing skills are distributed among the people of a population as a result of complex social processes, not shown. At any given time the distribution of skills within a population is fixed, and this distribution changes very slowly.


PRODUCTION NETWORK
Capital Goods
Processed Goods
Capital Goods
Capital Goods
Capital Goods
Processed, Goods
Production Management
Inventory Information
Market Forecasting
Rules and Laws
Productivity Factor Mix and Magnitude
Work Groups
RAW MATERIALS
Employment Rules and Laws
Rules and Laws
INSTITUTIONS
(Government and Social
Motives
1. Obtain volunteer role statu
2. Sustain identity through act
3. Other
Occupational Role Skills Pool
Motives
1. Obtain income to support desired and expected life style
2. Obtain occupational prestige
3. Other
PEOPLE
Needs
1. Primary group involvem
2. Semi-primary community
3. Point of geographic refer
SOCIAL LIFE

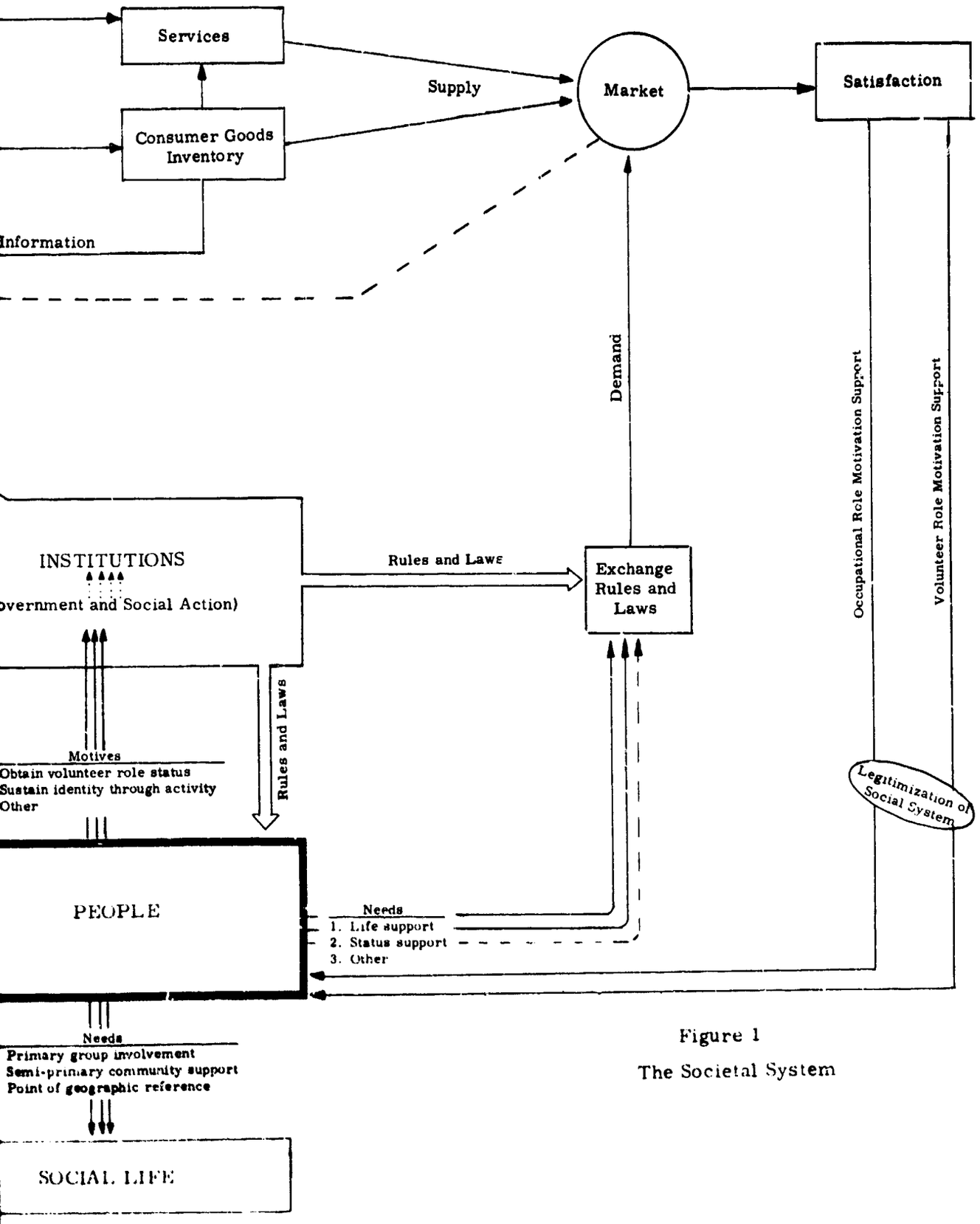


Figure 1

The Societal System

Role skills add quality to the effort available to the system. Thus, effort can be thought of as being available in a large number of different forms. The forms of effort available are normally closely related by the dynamics of social process to the forms needed in organizations. These forms of effort are not substitutable one for another. A man with one particular skill supplies effort effectively to the system when he performs his appropriate skill role and may have great difficulty supplying effort to the system in a different role.

The pool of occupational role skills, the physiological condition of the people and the number of persons in the population can be thought of as determining the upper limit of effort available for operating organizations. The motives of the various workers who make up this pool, employment rules and laws, and management decisions determine what portion of the potentially available effort is actually used in the system.

Each workman (the term applies to all participants in operating organizations of the system) has control over his own skill and energy. He may decide whether or not to make his services available to the system. His reasons for participating and his reasons for the intensity with which he participates in organizations are his motives.

B. Motives and Needs

Motives are derived from Needs; Needs are manifest in the goods, services, and opportunities for experience without which people are discomforted or worse. We have postulated that humans experience needs in terms of a hierarchy. Two types of needs are at the base of the hierarchy. These are life support needs and personality support needs. Life support needs include needs for oxygen, food, and water; shelter from the threatening aspects of the environment and some preconceived level of minimal health care. Personality support needs include the need for opportunity to share interaction regularly and frequently with a few persons who have familiarity with most of one's attitudes and beliefs and are to some extent cooperatively involved with one in living. They also include the need for

assurance that the meaning of the behavior of others will largely remain the same from day to day.

Societies are typically structured in such a way as to provide for satisfaction of the life support and personal support needs of most of their people. In our society, minimal needs for food and shelter (life support) and for opportunity for a close and frequent face-to-face relationship with family members and/or intimate friends (personality support) are rather easily satisfied. Most of us can take for granted that the worst calamity that might befall us will not expose us to starvation or isolation. Needs that are easily satisfied do not produce strong motives or account for large expenditures of energy. In normal times in our society, therefore, basic survival needs are not major sources of motivation.

Next in level of importance and closely related to personality support needs are status needs. These are one's needs to feel that he has an identifiable place in society and that he has access to opportunity and respect appropriate to this place in society.

Motives are the source of our goal-directed behavior. They emerge out of the discomfort we feel when needs are not satisfied or when we believe that continued satisfaction of a need is in doubt. Satisfaction of our status expectations is always somewhat precarious. In our society, in normal times, satisfaction of status needs is a primary source of motivation. If the satisfaction of lower-order needs is threatened, as in crisis, motivation would derive from and be related to satisfaction of these lower needs.

Status needs vary from group to group in a society. They are derived from the position and prestige to which a person feels entitled. The type and amount of position and prestige a person requires is a product of his early experiences in family life and in education. The complex process we call socialization yields different groupings of people with different status expectations and status needs in a society.

Status is made up of occupational prestige, volunteer role prestige, style of consumption (called life style), and the pattern of availability and use of leisure. Occupational role playing is, for most people, central to the satisfaction of status

needs, because occupation confers status directly and provides the income necessary for a desired style of consumption. There is, typically, strong motivation for persons with occupational skills to play appropriate occupational roles. Yet this motivation is tempered by the extent to which having and using leisure contributes to status. In a society that allows for substantial conspicuous consumption for most of its people, use of leisure is one form of consumption. This is to say that in our society, people are strongly motivated to play occupational roles during the customary hours of the customary work week, but that motivation to work longer hours and/or harder than is customary during working hours is tempered by the status rewards and other rewards available in the use of leisure.

C. Relationship to Productivity

This discussion may be restated in productivity terms. The productivity of a typical workman using appropriate tools during a normal working day is a function of his skill and motivation. His willingness to spend more or fewer hours working than is customary and his willingness to expend greater or less effort during working hours are all functions of his motivation, which is a function of the way in which his needs are being satisfied.

Since his status needs are derived from social customs and customs emerge from beliefs, effort expenditure is a function of the customs and beliefs existing in the society as well as a function of skill and physiological capacity.

Status needs are largely relative. The value-belief system manifest in rules and laws provides for more of available goods and services for people with high status than for people with lower status. The value-belief system defines this distribution as basically right and this differentiation exists because it is believed in. (Values have the quality of being believed in without recourse to explanation of why. Nevertheless, status is in part related to the believed-in importance of a role player's contribution to the functioning of society, and changes in the believed-in importance of specific functions for society are reflected in changes in related status.) People are typically satisfied when they receive enough goods and services to sustain the status they believe they are entitled to.

The "demand" that people exert on the marketplace is a demand that varies from group to group. Each group demands the goods and services appropriate to its status. Members of a group are typically satisfied when they receive goods and services appropriate to their status. When members of a group are thus satisfied, they will be motivated to continue the form and level of effort of occupational role playing that has been the basis for achieving satisfaction. To the extent that the people engage in volunteer social action, people from groups receiving basic satisfactions in the marketplace will choose volunteer roles supportive of the government and the system in general.

Thus, satisfactions from the marketplace combine with the existing occupational role skills pool and employment rules and laws to make certain quantities of each type of effort available to the production network.

Skilled man hours of effort characterized by "normal" motivations are combined with appropriate units of capital goods to achieve normal per capita goods unit productivity output.

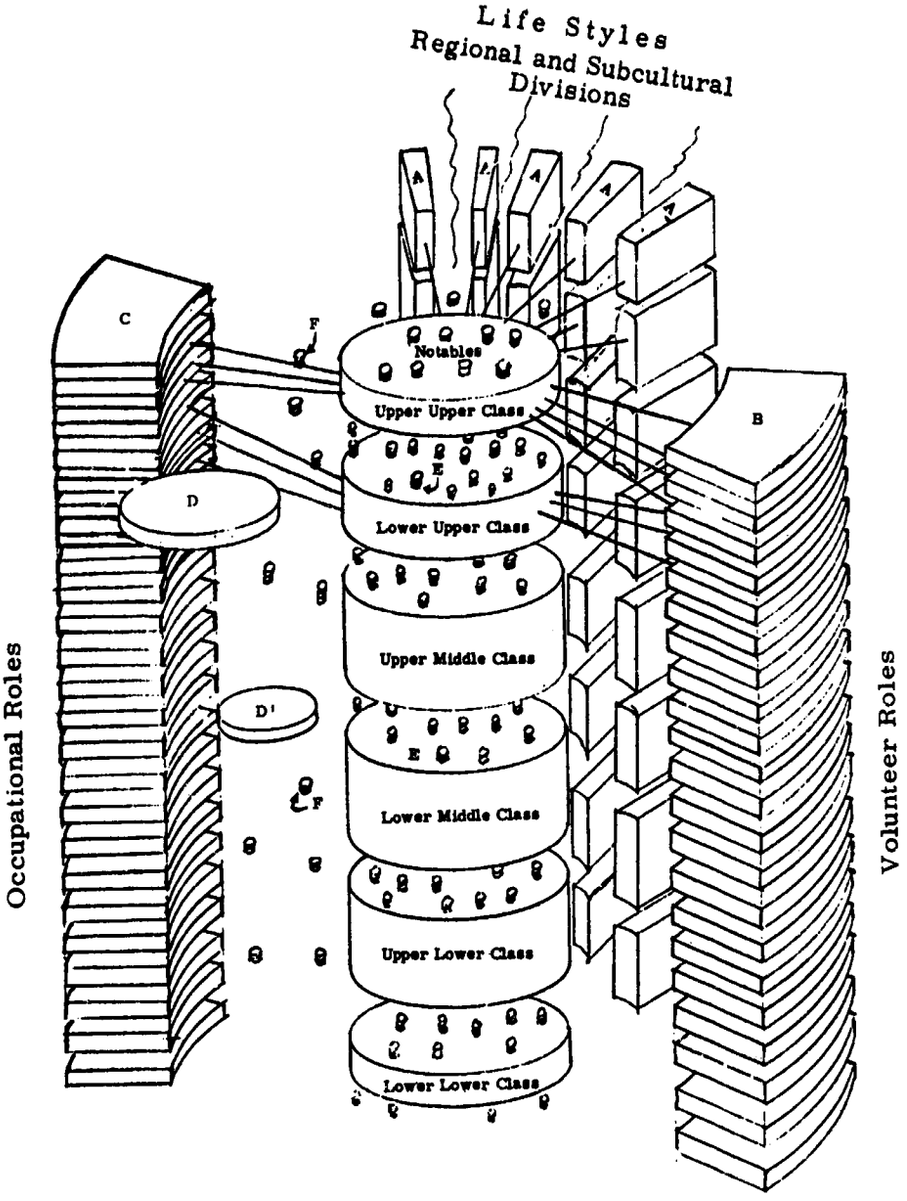
Most analyses of production on the basis of factors of production deal only with capital goods and raw materials. There is a hidden assumption that appropriate labor with appropriate productive capacity is available. The Production Network portion of the model is a representation of input-output type of analysis of production that includes labor as a variable. This allows for considering how production will be affected by significant changes in labor needs, skill availabilities and worker motivations. Since labor skill availability, changes in labor needs, and worker motivations can all be directly affected by crisis, this allows for including such considerations in post-crisis analysis. Since motivations of workers are affected by the changes in the way the societal system serves their needs and by necessary or experimental changes in rules and laws, there is a basis here for evaluating a post-crisis situation in terms of what rearrangements of rules and laws are most appropriate for hastening recovery.

D. Nature of Status Groups

People of a society are those who share societal values to the extent that they can participate in the basic institutions of the society. They are resident within the boundaries under the jurisdiction of the society's government. For our purposes, the most important thing about the people of a society is that though they are not all alike, they can be analytically divided up into homogeneous groups. The groups we focus on are status groups, made up of families of persons. The fathers in the families of a status group have basically similar occupations and income, and the families have similar life styles manifest in similar consumption patterns and use of leisure. Young people more frequently marry persons from families within their status group than from without. The beliefs of persons and their attitudes toward occupational role playing and volunteer role playing vary over a considerable range for each status group, but a substantial majority of the group members are very similar in beliefs, attitudes, and behavior. This latter fact makes it possible to analyze society on a status group basis rather than on an individual basis. Such analysis is oversimplified. However, the preponderance of similarity in attitude and behavior among status group members suggests that the oversimplified analysis is close enough to reality to be useful.

Figure 2 is a representation of the form of stratification of status groups in a society. Classes are clusters of families that could be further differentiated in terms of the age of the parents, the presence of both father and mother of the absence of one or the other in the family primary group, the presence or absence of children, the presence or absence of additional adults in the primary group and along several other significant dimensions. We believe the basic form and implications of social differentiation can best be shown without introducing this detail.

Between the classes in the diagram are representations of families, E, persons that are experiencing status mobility. Groups designated D and D' are made up of persons who have an ambivalent relationship to the status and value structure of society. Families designated by F are similarly, but each uniquely, déclassé.



A = Life Styles
B = Volunteer Roles
C = Occupational Roles
D = Indeterminate Status
E = Mobile--between classes
F = Déclassé

Figure 2

Social Stratification Model

Members of a class typically play occupational and voluntary roles that are located in their respective hierarchies at a point paralleling the class's status positions. There is some overlap, but only within the general neighborhood of status correlation. The column of Occupational Roles can be thought of as equivalent to the Occupational Role Skills Pool in Figure 1 above. Volunteer Roles occupy the position between People and Government and Social Action in Figure 1. Life Styles can be thought of as being located on the viewer's right of the People block in Figure 1. They are the sources of needs, particularly status support needs.

The Social Life aspect of Figure 1 is subsumed under Life Style in Figure 2.

E. Role of Values and Institutions

Values provide criteria by which a person interpretes his perceptions and judges which of the infinite variety of events and actions in his experience are important. You know when you have violated one of your values--you feel guilty and ashamed. When you have acted in accordance with one of your values, you feel enhanced and gratified. But values do not inhere in the individual along. Values are learned in interaction with other people from the cradle upward. They are particularly learned and sustained in primary group interaction. The institutions of a society are formed around and are a direct reflection of the values that its people share. They are particularly manifest in the laws and customs of the culture.

Institutions are the formal manifestations of values. The term institutions has been used in a variety of ways in contemporary literature. As used in this analysis, it is given a meaning more or less consistent with but less inclusive than the most common usage in contemporary sociology. A colleague has written, "The pattern of values, norms, attitudes and constraints which governs the choice and stabilization of functionally significant social behavior in concrete patterns of acts is an institution... social structure is a network of institutions which prescribes and specifies stable, recurring, limited ranges of actual behavior and actual

interconnected social patterns."[4] This definition must be narrowed a little to serve our purposes here and to provide a base for later developing the equations of a societal model. Our definition makes an institution a derivative of values rather than a category that includes values. Values are assumed to have an a priori quality and to be subject to very slow change. They are the basic points of reference of social life but they are too general to be adequate guides for specific behavior in typical daily social encounters. Every people derives from its values a complex of rules and laws to guide behavior in the life situations people typically encounter. The organizations within which these actions of deriving rules and laws for specific situations from values are performed are designated Government and Social Action in Figure 1. A legislature is an excellent example of the kind of organization that devotes itself to operationalizing values.

As the life situations of people change, rules and laws can be changed. Technological advances, increased population density, or the intrusion of a major disaster into social life can change the life circumstances that people must adapt to. One aspect of adaptation is the changing of rules and laws. Adaptation can be orderly as long as basic values remain as a reference around which the question of why, in making changes in rules and laws, can be argued. Several basic goals--such as the educating of the young, the producing of goods and services, and the preservation of public order--are objectives of the people of every society. In every society a complex of rules and laws is developed to prescribe and specify the form and range of behavior appropriate for serving each of these goals. The complex of rules and laws "designed" to foster a specific basic societal goal is, for our purposes, an institution.

In the literature of sociology and anthropology, a distinction between culture and society is often made. Culture is defined to include the values and rules of a people. Culture specifies what "ought" to be. Society embraces all the patterned behavior of the people who sustain the culture. It consists of what "is."

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[4] S. D. Vestermark, Jr. (ed.). "Vulnerabilities of Social Structure: Studies of the Social Dimensions of Nuclear Attack." (McLean, Va.: Human Sciences Research, Inc., December 1966, pp. 96-97.

The definition for institution used here makes institutions a major aspect of culture. Institutions are the complexes of rules and laws that prescribe what behavior ought to be in the seeking of major societal goals.

This requires modifying our colleague's definition of institution only to the extent that we state "culture [not social structure] is [largely] a network of institutions which prescribes and specifies stable, recurring, limited ranges of actual behavior."

The distinction is a very important one for the full development of the analysis being attempted here. It involves not only making the distinction between Rules and Roles (patterns of behavior) but of developing a systematic way that can be expressed in equation form of relating Rules to Roles. The same valued colleague mentioned above has written "...all social roles exist in the framework of cultural values to which role occupants must attend in some way."[5] Not only is this true, but, if we are to describe a societal system in equation form, we must be quite specific about how values affect role occupants.

The problem arises because roles are always played in reference to rules, but they are never mirror images of rules. Role players take rules into account but they do not conform exactly to rules. An experiment originated by F. H. Allpert[6] in the 1930's and sometimes called the Stop Sign Experiment illustrates this. If an observer is stationed unobtrusively beside a stop sign at a residential street intersection, in observing the behavioral response to the rule "stop" he will discover that forty to fifty percent of the motorists come to a full stop, over thirty percent slow down enough for a shifting of gears, around fifteen percent slow down but not enough for a shifting of gears, and two to five percent ignore the sign and do not slow down at all. This is the behavior at one type of intersection. It varies a little for busier intersections, but the pattern of partial conformity to the rules persists.

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[5] Ibid., p. 95.

[6] Floyd H. Allpert. "The J Curve Hypothesis of Conforming Behavior," Journal of Social Psychology, Vol. V (1934), pp. 141-183.

All role behavior is patterned response to a rule or complex of rules spread over some range of conformity. Role behavior takes into account the life circumstances in which the rule is applied. In disaster situations where some rules such as rules dictating respect for private property have become dysfunctional for the serving of a clear higher value such as the saving of human life, rules are set aside. Yet a rule set aside in an emergency comes back into force later unless some formal process of legislative or social action sets it aside. Some minor rules such as "blue laws" are set aside by "unofficial" common consent but a major rule such as the Eighteenth Amendment has to be repealed before social order can more or less comfortably ignore it.

F. Relationship of Institutions to Societal Functioning

In the diagram representing our concept of society as a system we have represented institutions as being derived out of social process through Government and Social Action, and we have represented the institutions as reaching out arms of rules and laws to organizational centers of society to control organizational functioning. In order to make this representation precise, we need to specify how the rules and laws influence role playing. We will specify, in developing equations, that role-playing behavior such as occupational role-playing behavior is a function of rules and of life circumstances. The task of making specific just what this means still lies ahead of us and will get attention in subsequent research. Life circumstances will be defined in terms of the connectedness of social linkages. Where social linkages are stable, the transfer function between rule and role will be empirically derived from experiments that are elaborations and generalizations of the Stop Sign Experiment. Where social linkages are constricted or borken, the transfer function will be diminished by some appropriate amount. Only when we have done this will we have systematically related culture to society. We cannot begin to do this without a clear distinction between culture and society. The definition of institution used here helps us make that distinction.

The problem is not solved when we relate rules to roles. We must also develop an explanation of how disruptions or dissatisfactions in the social system

create impetus for government and social action that brings about changes in rules. We hope to develop this further in future work. In the present state of the model development, we deal with social and psychological factors. In the next phase, we expect to deal more explicitly with cultural factors.

G. Relationship to Production Network

Organizations are the societal manifestations of institutions. They are made up of role players associated under institutional rules for the purposes of achieving institutionally specified goals. The government institution specifies the form that the public polity should take. The government organizations are the complex of roles played in defining the rules of the government institutions, in taking actions to interpret the rules, and in trying to insure that all people in the society conform to them. We can think of an institution such as government as singular while we find that government organizations are plural.

The various organizations engaged in the gathering, harvesting, and mining of raw materials and in the processing of these materials or in the providing of support for the processing of these materials make up the Production Network. The end-product of the Production Network is consumer goods and services. Industry, considered as an institution, embraces all the rules and laws that rule and guide the Production Network.

The Production Network is complex. Some organizations, particularly such capital goods producers as machine tool manufacturers, produce a product that they partially consume themselves; i.e., machine tools are used to make machine tools. Some organizations produce partially processed products that only become finished goods after being transported to other organizations for further processing. Transportation organizations constitute part of the network. Some organizations produce an output that is totally consumed by other organizations in the process of producing finished goods; i.e., electrical power. The same organizations utilize the finished goods output of some of the organizations for which they provide consumable goods.

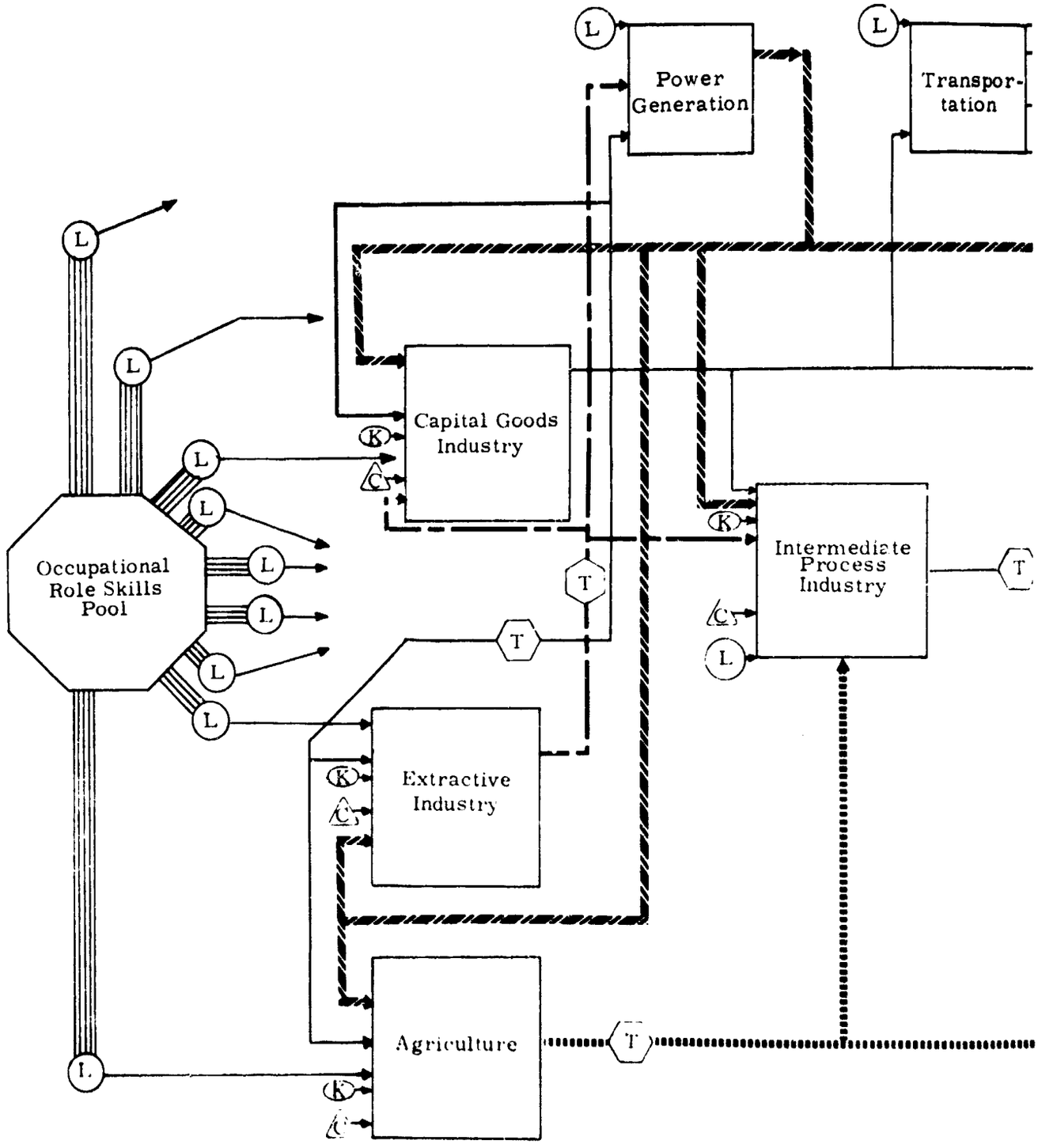
One way that this complex of relationships has been represented is in the form of an input-output table. Such tables have great utility for describing past states of the economy and for forecasting the future under the circumstances where factor mix and factor productivity remains unchanged. They have somewhat limited utility when one is concerned with the ecology of production, changes in factor productivity, particularly labor productivity, and changes in managerial decisions regarding factor mix. Traditionally, such analyses do not treat labor productivity as a variable.

We prefer to represent the same relationships in the form of a flow network. Such a representation permits identification of network vulnerabilities. A highly simplified diagram of a part of this network is shown as Figure 3. A diagram that represents a typical industrial organization is shown as Figure 4. In Figure 4, the small circles, each surmounted by a "T," are meant to represent valves or points where managerial decisions, labor productivity characteristics, or technological change can cause changes in the rates of flow.

This general type of elaboration and the flow equations that express the relationships mathematically are necessary for each block of the societal diagram. They either have been or are being developed for each block.

Effort can best be quantified in terms of productivity per man hour. Each type of skill can be categorized as having a "normal" man hour productivity. Various factors such as the quality of tools and raw materials available, the quality and quantity of support from other skill role players, and the motives of the role player himself can be thought of as multiplying coefficients applicable to an empirically derived normal man hour productivity for a skill.

Effort is the source of activation for the societal system. Through application of effort, goods and services are produced and rules and laws are changed. Satisfactions are the product of effort applied in the system, and effort is even required for the enjoyment of social life. In proceeding to use the model as a basis for analyzing society in states of crisis and change, we can focus on how different factors, particularly social and psychological factors, affect effort.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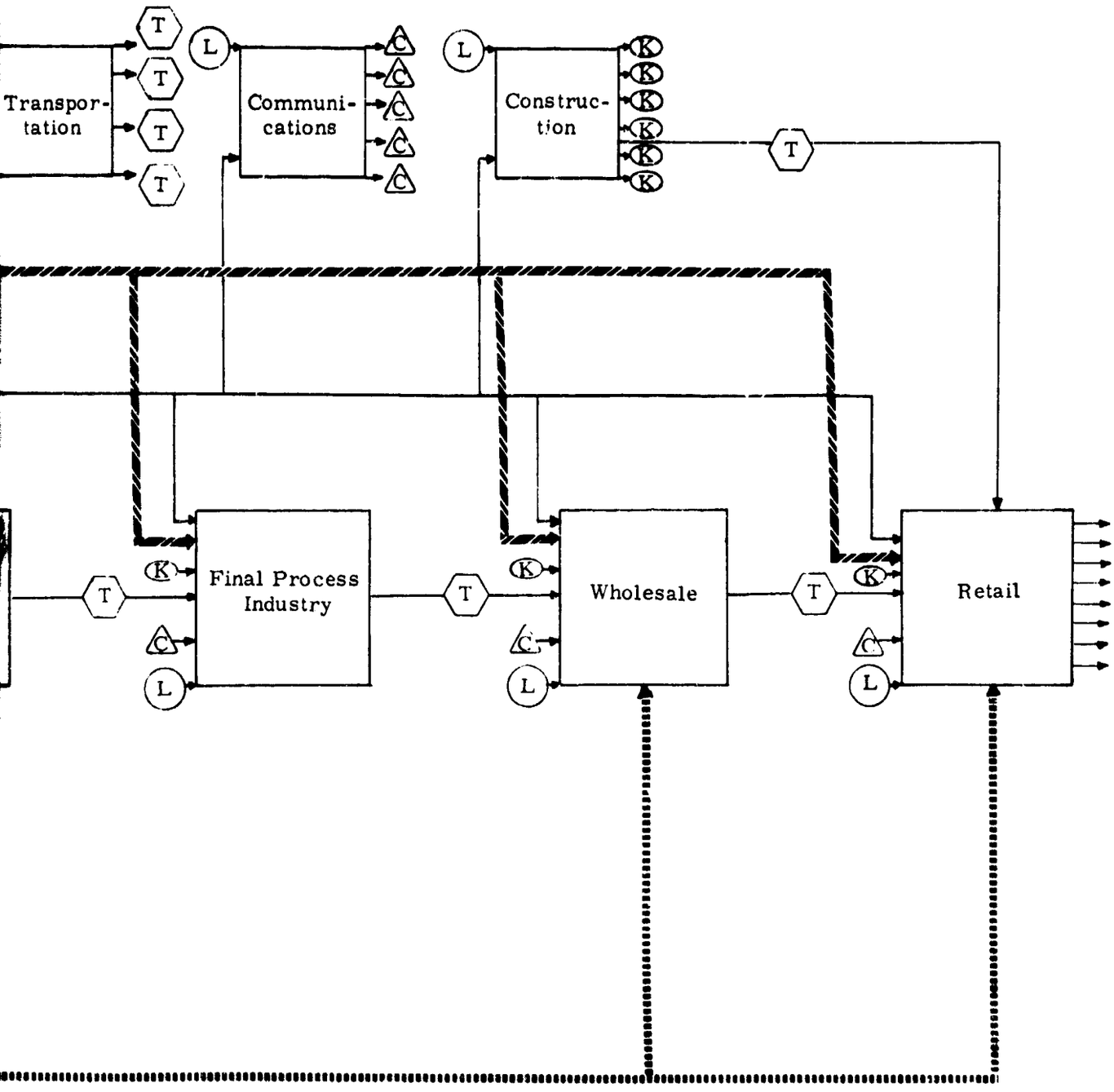

Figure 3

Partial Diagram of the Production Network

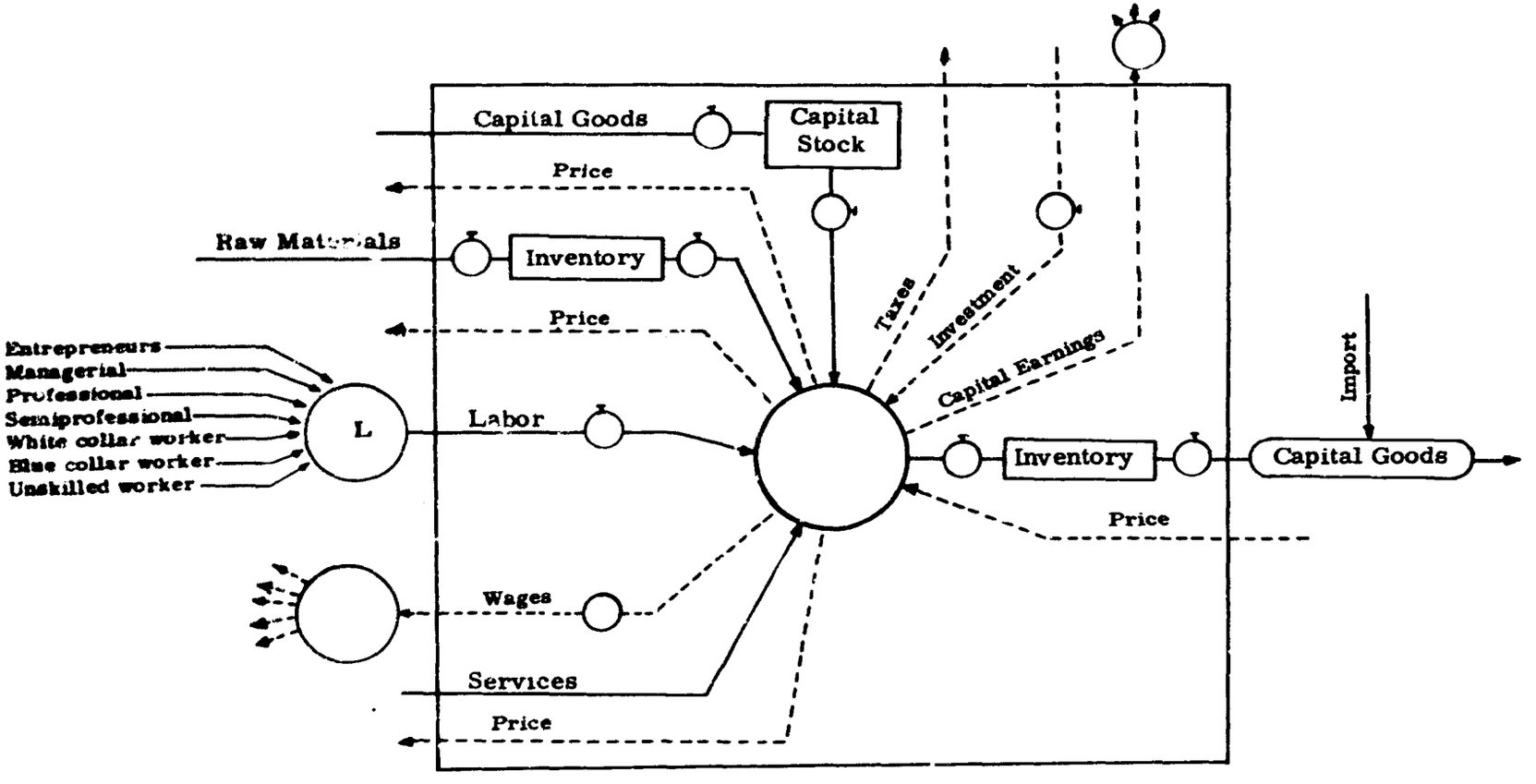

Figure 4

Internal Sector Characteristics

Since we have defined viability in the introduction in terms of both survival of people and in terms of popular support for the government system most directly derived from the pre-crisis system (i.e., in terms of survival of the institutions manifesting our current value system), and since we can relate occupational role effort and volunteer role support of the system to types of satisfaction in the marketplace, we have a basis for estimating what the problems of survival of our social system after crisis are.

III. CHARACTERISTICS OF SOCIETY UNDER STRESS

A. General Functioning of the Societal System

A society is made up of elements and linkages. Elements can be thought of as situations where operations take place. The carrier that flows through the system is operated on at an element in such a way that some change in its characteristic takes place. The linkages are the means of transferring the carrier from element to element for subsequent operations. A system is stressed when elements are damaged and destroyed and when linkages are constricted or broken.

Probably the greatest stress a modern society might experience is nuclear war. We will describe how a society is affected by nuclear attack, both as a means of better explaining the model and as a contribution to the OCD dialogue dealing with recovery of the societal system.

Efforts to understand the problems of recovery from nuclear attack have largely dealt with an inventory of material wealth that has been damaged and destroyed and of people who have been killed or injured. From the standpoint of our systems model of society these questions, though legitimate, do not probe the problem deeply enough. If we want to fully comprehend how we have been hurt by an attack, we must determine not only what elements have been damaged and destroyed, but also where these elements are situated in the societal network. We must also determine what linkages have been constricted or broken.

Repairing and rebuilding the system will consist of rebuilding elements and reestablishing linkages. We must look at the total system, as it has been damaged, and determine which elements and which linkages that have been damaged or destroyed are most crucial for systems functioning. These are the elements and linkages, both physical and psycho-social, that must get repair attention first. We must concern ourselves with keeping the system operating and with what repairs and readjustments are most productive for continued systems operation.

The production network is a subsystem network, within the societal system. It is crucial because it provides the goods and services that serve people's needs and yield satisfactions and motivation. We can identify major groupings of elements within this network, such as finished consumer goods industries, parts producers for finished consumer goods industries, capital goods industries, energy producers, agriculture, mining and drilling industry, transportation-heavy goods, transportation light goods, transportation-people, communications and supporting services. We might further break down the network industry by industry and describe it with a flow diagram that includes both elements and linkages. (For simplicity we have not noted the importance of the fiscal network for the functioning of the production subsystem. We subsume it here under communications.)

We can attack such a network by destroying operating units in each industry and damaging others. The consequence is reduced potential output capacity. In simulating an attack, we can also break or constrict power supply, transportation and communications linkages. Immediate postattack potential production output is the output of whatever industrial operating units remain functionally linked in a production chain. Potentially operable units cannot contribute to the system when some of their crucial linkages are cut. Links are useless without something to transport.

The term "potential" has been used above with reference to operating units because we have been discussing the artifacts of production without reference to the human effort that is needed to activite the Production Network. Much human effort resides in the Occupational Role Skills Pool of a society. The motivations of the skilled persons are key links between the Occupational Role Skills Pool and the Production Network. Effort from work groups made up of appropriately skilled workers is a necessary factor of production. Depletion of the worker pool and/or constriction of occupational effort due to changes in motivation can leave a potentially productive factory or other operating element idle or only partly productive.

Human effort,[7] as noted in the discussion of People and the Occupational Role Skills Pool in the model, is supplied to the system in different forms. Each skill group supplies its own type of effort. Groupings of similar skill groups make up each social class. We will treat each class as an element of the societal system.

The people of a class are linked to the network of operating organizations of the societal system by Motives, Employment Rules and Laws, Employment Accessibility (geography) and Volunteer Role Opportunities. Motives, Employment Rules and Laws, and Employment Opportunities link potential occupational role players with the Production Network.

Motives derive from precariously satisfied needs. They presuppose the satisfaction of needs lower in the needs hierarchy. Lower needs have the character of being potential threats to the motive linkages. If the lower needs are not satisfied they tend to constrict the flow of effort along the motive defined channels. This effort may be partially absorbed by anxiety or it may be partially or completely shunted into activities directly related to the immediate satisfying of lower needs.

Using a simple hydraulic analogy, we can consider the lower needs as being like bypass valves in the lines through which human effort normally flows. Uncertainty regarding the satisfaction of lower needs can constrict the flow of effort along typical system support lines and can divert some of the effort away from system support into direct individual or family support channels. Normally the main valves are wide open and the bypass valves are closed.

As noted above, in our society much of our motivation is derived from status maintenance needs. Status is maintained by playing appropriate occupational roles, by gaining and using an indome in appropriate life style fashion, by having and appropriately using leisure, and by volunteer role playing for some in each

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[7] The term effort is nearly equivalent to the term labor which we would use to refer to effort in a more casual discussion. However, because labor and associated terms like labor force have other connotations that are inappropriate for post-attack usage, we will use the term effort. The term energy would be used instead of the term effort if it had not already been established as referring to non-human sources, such as electrical power, in the OCD dialogue.

class who need to augment status by playing appropriate volunteer roles. Since status is, in part, directly derived from occupation, most workers develop positive attitudes to playing occupational roles without being aware of the source of their motivation. Men seek to play appropriate occupational roles because it is "good" to play these roles. It is good and "dignified" to work in the field in which one is skilled.

Motivation to play occupational roles does not automatically produce occupational role players. Rules operating to control the employment marketplace dictate how many occupational role players of a certain type can find employment. The level of productivity chosen as a goal by managers imposes a requirement for role players in certain occupations. Managers, responding to employment rules and laws, have considerable control over who will work and how long each worker will work. Employment rules and laws affect the employee as well as the employer. They suggest to him what constitutes acceptable circumstances for employment. Occupational role prestige derives from working at one's occupation in an appropriate way, not just working at one's occupation.

Another important source of occupational role-playing motivation is wages. Money is not a goal in and of itself. It is a means through which one can exercise demand on the production and service processes of the system. Each class group expects to be able to exercise a demand on the production process appropriate to its status. Demand is exercised through the market. This demand is relative. A status group expects its share of the total system output of goods and services. The higher the status, the greater the expected share. In the case of an individual this means that he expects, in general, more goods and services than the goods and services demanded and received by persons who are members of lower status groups. As the gross national product increases, the absolute demands and expectations of members of each status group increase in proportion to their status. (While consumer demand tends to be sticky in the downward direction, in the event of a major crisis such as nuclear war it seems reasonable to expect that a downward adjustment of all status levels would be widely accepted.)

The process of exercising demand on the system for each status group involves participation in the market in accordance with the society's exchange rules and laws. These rules and laws embrace savings and investment practices, borrowing and lending practices and the many other practices of consumer finance. Thus, satisfaction of life style motivation depends on income and the functioning of all of the exchange rules and laws of the society.

In normal times some members of each status group find themselves with status needs unsatisfied by occupational prestige and by their life style. Such persons can turn to volunteer roles at their appropriate level for additional prestige. The various social action organizations of the society provide volunteer role status and provide the means through which modifications in customs and some modifications in laws are achieved. The volunteer role players in social action organizations typically represent their class's interest in their social action activity. General satisfaction among class members with their life circumstances leads to systems maintenance activities among their volunteer role player representatives. Dissatisfaction among class members leads to efforts on the part of their volunteer role player representatives to change rules and laws. Increased dissatisfaction among members of a class leads to increased numbers and increased intensity of volunteer role players who agitate for socio-cultural change. Dissatisfaction thus operates in several ways to deplete the effort channeled to occupational role playing in the Production Network. It draws some effort out of this subsystem into the social action subsystem; it reduces effectiveness of effort expended due to antagonization and it draws effort from other strat to respond to its expressions.

A system like ours can and does survive and grow while experiencing a continuing struggle among class and interest groups in the Government and Social Action arena. Our society has a substantial excess of effort and a substantial cushion of growth capital. We can afford somewhat expensive forms of social action.

The rules and laws that define the operation of the fiscal system and largely define the meaning and value of money thus constitutes linkages that connect human effort to production, just as the rules and laws of the employment system do. Both

are highly dependent upon a complex accounting system. The information subsystem used in production management is also a crucial linkage system between occupational role players and the Production Network.

An overview of our society suggests that we probably have a substantial reserve of human effort. The four or five percent of the labor force that are unemployed represent a relatively small reserve with limited skills. The major source of reserve is to be found in the leisure that we grant ourselves. Contemporary Americans work a forty-hour work week. Historically, Americans have worked sixty-hour and seventy-hour work weeks and considered this normal. We may reasonably presume that under new conditions of motivation and necessity, we could call up an effort reserve that could increase per capita output by thirty to forty percent. By utilizing existing capital goods on a two-shift and three-shift basis and properly distributing this effort over replacement, repair, and maintenance activity as well as in consumer goods production, we might just balance capital goods utilization against available effort.[8]

B. Functioning of the Societal System under Stress

At this point we turn our attention specifically to a nuclear attack on the system. An attack will destroy and damage much of the means of production and will kill and injure many people. Within the Production Network some undamaged or lightly damaged elements will be rendered ineffective by constrictions and breaks in linkages. Repair of elements and of linkages will become a major concern. Even if the damage to the production system were just equivalent to losses of people, per capita production would be significantly degraded due to the disruption of linkages.

The elements and linkages in the People subsystem are our particular concern. Skill groups linked through location, transportation, and custom to a particular operating facility are the basic elements of the People subsystem.

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[8] These are crude speculations to suggest the dimensions of the preattack situation. They should not be treated as critical estimates.

Some of these people will be lost due to death or injury. Others will be alive and physically able, but their effort will be limited because of geographic dislocation and breaks in transportation and communication. Some of the physically able will have their productive effort constrained because of the intervention of lower needs than those served by occupational effort--the "bypass valves" will be open.

Some of the people who are physically able will be victims of psychological states that reduce their occupational motivation and the effectiveness of their effort. Some will be aware of the probable breakdown of the accounting system that gives meaning to money and will tend to withdraw from occupational effort until they can see that wages have meaning for consumption and life style.

In general, some People elements will be damaged or destroyed and the motivational linkages that channel skilled human effort into operating organizations will be significantly constricted and in some cases broken. We are not yet able to give a complete description of linkage damage in the People subsystem, but we can offer discussions of some of the problems that will arise.

People will differ in terms of how satisfaction of their personality support needs is affected by the attack. Personality support needs begin with one's needs for a family or similar primary group. Personality support also depends on assurance that some degree of regularity and predictability will exist in the social world day after day. A person who feels threatened in these areas is strongly motivated to find his family members and to find a place of shelter for them where he can leave them and expect to be able to return to them. We have called the "seeking-a-place-of-shelter" aspect of personality support needs the "need for a geographic point of reference."

A family group united and located may not fulfill all personality support needs. Family groups will seek to further stabilize their social environment by locating among friends and neighbors. They will seek personality security in their geographic location and rights to the artifacts they use in daily living. Displaced persons will seek to return to their original homes whenever this is possible

We are dealing here with needs that have priority and that will be the source of motives. People will be motivated to act in what seems to them to be the most effective way of satisfying these needs. Competing system support claims on their effort will get little attention until the most basic needs are satisfied. These claims will get less than full attention until a stable environment for family life is established.

We can usefully classify the postattack population into groupings that include: (1) broken families; (2) intact families separated from neighbors and friends and without geographic reference; (3) intact families with a point of geographic reference, but without neighbors and friends; (4) intact families with friends and a point of reference, but displaced from homes; and (5) persons not displaced from preattack personality support reference.

The effective effort available for system support from people in the first four groups will be reduced over that available from people in group five by some significant factor. The reduction coefficient will be greatest for group one.

We can briefly note here how postattack management can influence postattack productivity. If refugees are guided in such a way that they can be reunited with family and among friends in a geographic location with customary privacy and rights of occupancy, they can be expected to provide more effective effort in support of the societal system than they otherwise might. We note that this will require not only good communications but also some modification of rules and laws to permit need satisfactions in the new life circumstances. The modification of rules and laws must be within the culture's basic value system. Redefinition of property rights within the framework of basic values can have a positive relationship to improved societal system functioning. Discussions and plans for postattack indemnification of persons suffering property loss should be developed with reference to societal system structure and function.

A situation very similar to that involving uncertainty of personality support will emerge in regard to basic life support. Persons who perceive that food, water, and shelter may become scarce will give effort to obtain these, first priority. Where foraging or scavenging is feasible, such behavior may absorb a great deal of

effort. These needs will be redefined by the new circumstances, but not without reference to preattack customs. People who have experienced great destruction around them and who have temporarily lost status orientation will accept a survival diet of nominally acceptable foodstuffs as fair and will respond with systems support effort if they expect that this supply of food will be sustained. All such adjustments will be modified over time and will be influenced by postattack management and communication. Revised rules and laws that adjust the system of exchange to the new life circumstances of people within the culture's basic value system can be important for societal system functioning.

Rules and laws relate people to people and people to things. They are the product of an experimental process in Government and Social Action where people try to make their values have specific consequences. Each rule and each law applies to a situation where the complex network of artifacts and other rules and laws also constrains the situation. Laws that deal with property ownership relate our values to the material goods available to be owned and used. They apply to a specific stock of material goods within a historically established framework of distribution and accounting. When this stock of goods is partially destroyed and partially damaged, when the artifacts of the accounting system are partially destroyed, and when some significant number of people who have "legal" claims on surviving property are killed, the preattack property laws will not be functionally applicable.

Research on local disasters suggests that people place values ahead of laws and break laws when a basic value orientation and the emergency situation suggest that breaking the law is functional. Widespread acceptance of the value involved and an obvious relationship between the law-breaking behavior and the support of the value makes such behavior possible with limited social confusions. In such situations there is the stability of the larger society to cushion confusion resulting from such behavior.

In the postattack situation the entire society will be suffering the disaster. Many laws and rules will not be adequate expressions of the values they were "designed" to operationalize. The people in various types of disaster situations--i.e., near miss, remote miss, having stable geographic points of reference or

refugees, etc.--will spontaneously adjust their behavior to the new situation as they understand it. Groups of people with strong pre-crisis group identity will be somewhat more successful than heterogeneous groups. A good deal of effort will be absorbed in experimenting with adjustive patterns of behavior. Some attempts at adjustment will be counterproductive and, after some confusion, will be abandoned.

We can be reasonably sure of two things. First, people will act to develop behavior patterns in the new situation on the basis of preattack values. People will not panic or become excessively egocentric. They will try to cooperatively get along. Secondly, in the disturbingly different life situation of the postattack world, a good deal of effort will be absorbed by the experimental process of redefining culture and society. In one sense we can think of the problem of societal redefinition as a new demand imposed by the attack on the system. This new demand will absorb a good deal of the managerial and operational effort that is available.

A rule that expresses a basic value and that seems functional for the postattack system will probably gain ready public acceptance. Such a rule will tend to reduce the amount of experimental effort that is absorbed in role redefinition. Our systems model of society can be used to help us identify the areas where redefinitions of rules and laws may be most important for postattack system functioning.

Some definite psychological effects that will influence motivation will be related to the location of persons at the time of impact. Those persons who experience the attack as a personal near miss and who observe, firsthand and immediately, large-scale destruction and death will be somewhat overwhelmed by their experience. Their initiative will be stunned. They will respond well to direction but in mechanistic fashion. Their effective effort will be significantly reduced by their experience. This effect will fade with time but will last for some for many months. Because the productivity coefficient applicable to persons who have experienced a near miss can be reasonably assumed to be different than that applicable to persons experiencing a remote miss, it is necessary for planning and management that we be able to divide the postattack population along these lines.

Another psychological effect that is stronger among people experiencing a near miss than among persons experiencing a remote miss is frustration-aggression. The intense diffuse aggression evoked by disaster experience will have a negative effect on effort. Near miss persons will become more aggressive than remote miss persons. This effect must be separated from the stunning effect of a near miss because of its tendency to grow rather than decay with time.

Any massive nuclear attack will kill a great many people. Some communities will be hit harder than others. Customs and beliefs will impose a new service demand on the system. People will expect the dead to be buried. Burial customs will be modified because of the large numbers of dead that must be handled at once. The burial service will call for efforts from several different types of persons--organizers and managers, health specialists and laborers.

The attack will also produce a large number of injured persons. This situation, customs and beliefs, and devotion of primary group members to each other will impose a vastly increased demand for health services on the system. All available persons with health service skills will be called on to play their health service roles. The value system and individual needs to sustain family and other primary group ties will impose a demand on health service personnel for an effort output exceeding normal intensity and exceeding normal forty to sixty hours per week of work. Supply will, nevertheless, probably fall short of demand for some period of time. Customs and values will dictate that sick persons not otherwise cared for receive care and attention in their homes. This area will absorb some effort that otherwise could be devoted to the production process. Custom will dictate that most of the care for the sick will fall to women. The large male contingent in the occupational roles skill pool will be only modestly affected.

Rescue demands on the system will have characteristics quite similar to those imposed by injury and sickness.

These are some factors that will contribute to the amount and quality of utilizable effort after the attack. We can anticipate some rebound effect on the part of surviving workers that would increase available man hours per man and the quality of the hourly effort expended. Some substantial analysis must be

performed if the nature of this rebound effect is to be adequately assessed. National pride will probably account for some rebound effect that can be applied as a multiplier to nominally available effort.

Persons with disaster-related skills, such as construction workers, telephone linemen and health service workers, can be expected to perceive their roles as important. They can be expected to respond to requests for effort with willingness to work long hours and with greater than normal hourly expenditures of effort unless other factors intervene. Perceiving the importance and the prestige of exercising one's skill multiplies the quality and quantity of effort one gives in a disaster. The more skilled persons in the population tend to perceive their roles as more important. They also tend to occupy the upper portion of the social stratification structure. Upper status people may, on the average, be more highly motivated to exert system support effort for this reason. (Immediately after the attack there may be some notable exceptions where unskilled or semi-skilled labor seems very important.)

On the other hand, persons without disaster-related skills and persons who do not perceive their role to be important will be somewhat frustrated and the effectiveness of their effort will be somewhat less than otherwise expected.

There are many social, psychological and related factors that will influence the linking of skilled human effort to the operating organizations of the society. Some systematic way for taking them all into account is needed. We believe that the systems diagram itself suggests the solution. We have proposed that another form that it could take is that of a family of equations. We believe that operational use of the model requires that social, psychological, and related factors be set forth as coefficients applicable to the equation form of the model description. Our progress in this direction is reported in the following section.

IV. THE MODEL IN EQUATIONS FORM

If the conceptual model can be represented in the form of a family of equations we can be much more precise in answering questions about postattack and other crisis and change states of society, about questions regarding viability of society, and about the consequences of various management decisions on post-attack recovery.

The present conceptual model is an embryo. It must grow a great deal to become the full-fledged tool we desire. Yet, we believe, the basic functional relations are present and we can use the embryonic form to guide analysis. If the conceptual model is a system, the mathematization of the model can be formally achieved. We do not pretend that the equations presented are adequate in anything but a formal sense. However, they represent a beginning. Operational use of the model is, we believe, most promising when it is used in its mathematical form. What follows is a first, crude iteration in the development of a family of equations to describe society.

Definition of Terms

GS = Supply (goods and services/wk.)

C = Consumption (goods and services/wk.)

I = Inventory (goods)

ue = Utilizable effort (standardized 40 hr. man weeks)

re = Applied technology research effort (standardized 40 hr. man weeks)

rep = Repair effort (standardized 40 hr. man weeks)

ee = Total effort expended (standardized 40 hr. man weeks)

ae = Available effort (40 hr. man weeks)

M = Able-bodied workers

AE = Available effort per worker (hrs. /wk.)

L = Leisure per worker (hrs. /wk.)

VR = Voluntary role playing per worker (hrs. /wk.)

TT = Travel time per worker (hrs. /wk.)

LSE = Direct life support effort per worker (hrs. /wk.)

PSE = Direct personality support effort per worker (hrs. /wk.)

VSE = Volunteer service role playing (hrs. /wk.)

VRA = Agitation role playing (hrs. /wk.)

K_T = Research-Technology conversion factor

K_R = Repair-Productivity conversion factor

K_M = Overtime and moonlight correction factor

K_I = Inventory-Life Support conversion factor

K_{rf} = Refugee-Personality Support conversion factor

K_{si} = Sick and injured-volunteer role conversion factor

K_L = Leisure preference coefficient

K_{TT} = Transportation disruption coefficeint

K_{ai} = Agitation coefficient

K_{ss} = Societal stability coefficient

R = Percent of survivors refugees

SI = Percent of survivors sick and injured

t = Elapsed time since baseline condition

$\frac{GS}{ue}$ = Labor productivity coefficient

$\frac{GS}{ue_T}$ = Technology productivity improvement coefficient

$\frac{GS}{rep}$ = Repair productivity improvement coefficient

Z = General motivation coefficient

Z_1 = Post-disaster shock

Z_2 = Post-disaster frustration-aggression

Z_3 = Billeting and privacy factor

Z_4 = Separation from family factor

Z_m = Utility of wages factor

Z_{ss} = Perceived social stability factor

Z_{BB} = Rebound effect

Z_{SP} = Special role significance factor

C = General communications factor

Y = Skill substitution factor

Subscripts

$_{o}$ = Condition at time zero (preattack baseline)

$_{t}$ = Condition after elapsed time t

$_{A}$ = Condition in the postattack period

$_{A-o}$ = Condition at postattack baseline

$_{T}$ = Function utilized in technology process

Factors designated by prime (') indicate coefficient applies only to a select group and not to the total population.

There are three basic equations that we will work with. They can be related to the societal system diagram--Figure 1. The first equation states:

$$(1) \quad GS = \frac{GS}{ue} \cdot ue$$

This expresses the basic relationship between effort and supply. It can be thought of as the basic equation across the production network portion of the model. The expression $\frac{GS}{ue}$ can be thought of as the production network transfer function.

The second basic equation states:

$$(2) \quad ee = ae \cdot Z \cdot C \cdot Y$$

This expresses the relationship between the man hours that are available to be used by people in pursuit of occupational roles and the quality of the effort that is made available as a consequence of motivation, communication and role unfamiliarity or role substitution. The term Z, the motivation function, can be thought of as the basic transfer function across the people element of the system.

The third basic equation states:

$$(3) \quad AE = 91\text{-}L\text{-}VR\text{-}TT\text{-}LSE\text{-}PSE$$

This expresses the summation of demands imposed on a workman's time (168 hrs./wk.) after basic requirements for sleep, consumption, and primary group relations are subtracted (56 hrs./wk. for sleep; 21 hrs./wk. for meals and primary group fellowship). This equation allows us to show how different life circumstances and changes in rules and laws change the ways in which workmen spend their time.

The feedback of satisfaction or dissatisfaction with opportunities in the market to the performance of people is shown in aspects of both equations 2 and 3. These and other relationships that tie the system together are shown in the development of the details of the three basic equations.

Equation 1 states that supply is a product of the labor productivity coefficient and utilized effort.

$$(1) \quad GS = \frac{GS}{ue} \cdot ue$$

The term utilizable effort (ue) expresses both quantity and quality. It is a representation of the total number of hours worked during a period of normal societal operation divided by forty and is written in man weeks. It implies that the forty hours of effort are delivered by workers with skills appropriate to their tasks and with motivation appropriate to normal societal functioning. Subsequently we will discuss available effort (ae). The difference between available effort and utilizable effort, as the terms are used here, is in the difference in quality of the hours of effort expended. Equation 2 deals with how this correction is made.

$$(2) \quad ee = ae \cdot Z \cdot C \cdot Y$$

Equation 3 will be discussed later. First, a number of other equations bear on the problem.

The productivity coefficient $\frac{GS}{ue}$ is not a fixed coefficient. It changes with time. In our society, technological improvements continually increase the productivity of labor. If we know the labor productivity coefficient at time zero ($\frac{GS}{ue_o}$) we can calculate the labor productivity coefficient at time "t." For any period in the past, chosen to represent time zero, we can calculate the average societal productivity coefficient by using Departments of Labor and Commerce

data. We can assume that technological improvement is a function of how much applied research effort is expended.

$$(4) \quad \Delta\frac{GS}{ue_T} = K_T \sum_{o}^{t} re$$

The transfer function between applied research effort and improved productivity, K_T, is presented here, for simplicity, as a constant. It must be derived from data about successive periods in the recent past and is probably not a constant but a function of the level of technological development, $\frac{GS}{ue}$, existing at the time to which it is being applied. Neglecting this refinement we may write:

$$(5) \quad GS_t = \left\{\frac{GS}{ue_o} + \int_{o}^{t} \Delta\frac{GS}{ue_T}\right\} ue$$

Note that the basic expressions, GS and ue, are flow terms, not stocks. They refer to the supply produced per week and the man weeks of effort being utilized per week at time "t."

In dealing with the postattack situation we do not expect to be concerned with technological improvement in productivity. The problem, most likely, will be to try to recover to some level of productivity previously achieved rather than to develop new industrial technology. Productivity will have been decreased by virtue of damage to capital goods and breaks in linkages. A protocol for determining postattack productivity based on attack damage information must be developed. There is a good deal of information scattered in literature dealing with maintenance, industrial engineering and production management, about the effects on utility of machine tools and other capital goods of misalignment, damage, wear, under-voltage, etc. It is out of this body of information that we invision the development of the protocol for estimating the productivity of the postattack stock of capital goods. This protocol will provides us with the productivity coefficient applicable to the immediate postattack situation ($\frac{GS}{ue_{A-o}}$).

We may assume that repair effort will have the same type of relationship to postattack productivity that applied research has to preattack productivity.

$$(6) \quad \Delta\frac{GS}{rep} = K_R \sum_{o}^{t} rep$$

Thus at any time A-t, productivity will be:

$$(7) \quad \frac{GS}{ue_{A-t}} = \frac{GS}{ue_{A-o}} + \int_{o}^{t} \Delta\frac{GS}{rep}$$

and supply at A-t will be:

$$(8) \quad GS_{A-t} = \left\{ \frac{GS}{ue_{A-o}} + \int_{o}^{t} \Delta\frac{GS}{rep} \right\} ue_{A-t}$$

The total effective effort being expended in the system at any time, postattack, will be:

$$(9) \quad ee = ue + rep$$

One very important postattack management decision will be one dealing with how to divide up available effective effort between direct production effort and repair effort.

Expended effort, ee, in the preattack situation is a function of production management decisions, employment rules and laws, and supplied effort in the form of skilled workers' willingness to work. Custom dictates that for most people this represents forty hours per worker of motivation effort per week. A fraction of the labor force moonlights, largely to sustain status-related consumption expectations so that the average preattack hourly effort per week may be 42 hours. Supplied effort can be expressed as:

$$(10) \quad M \times K_M = ue$$

In normal circumstances $K_M = 1.05$ (i.e., $\frac{42}{40}$).

$K_M = f$(custom, perceived emergency and $\frac{\text{consumption expectations}}{\text{consumption}}$)

This holds true as long as working additional hours is productive of income that can be functionally used to increase consumption. In normal times custom is established and need not be considered a variable in calculating K_M. In normal and non-emergency situations we would expect that consumption expectations, on the average, exceed consumption by about five percent if the several assumptions made above are accurate. This suggests that there is normally in the society a certain dynamic dissatisfaction with consumption that is just offset by the dissatisfaction component of average worker effort that is five percent above the normatively defined "right" amount of worker effort. This provides some quantitative indication of how willing workers are to give up leisure in order to increase consumption in normal times. It can serve as a point of departure for estimating how much leisure workers would be willing to give up in a postattack situation in order that they might increase their share of postattack goods and services. Thus, derivation of the preattack overtime and moonlighting correction factor (K_M) for normal (preattack) society can provide a point of departure for derivation of the leisure preference coefficient (K_L) used in equation 20 below.

We assume here that for most skilled workers there is as much moonlight work available as desired. This is certainly open to question, but for this simplified analysis, it can stand as a first approximation.

The basic point we are attempting to make is that, as long as wages can be translated into consumption, there is a relationship between willingness to work "overtime" and the ratio between consumption expectations and consumption. We have here an initial basis for determining the form of this relationship from preattack data. If we determine this function for preattack data and develop a protocol for determining how consumption expectations are downgraded by an attack, we may be able to systematically relate worker willingness to work longer hours to reduced consumption. This relationship is linear only for a limited range. Obviously there are physical factors that limit how many hours a worker can work. There are other factors that limit how many hours he may be willing to work. [Note consumption as used here is equal to supply + Δinventory.]

Available effort for occupational employment per worker per week can be computed on the basis of 168 hours in a week and on the basis of physiological requirements--i.e., approximately 56 hours per week sleep; psycho-social requirements--i.e., 21 hours per week for meals and other intervals of primary interaction with family and friends; and on the basis of alternative choices available for disposing of the remaining 91 hours.

AE = 91, minus leisure, minus volunteer role activity, minus occupational travel time, minus direct life support effort, minus direct personality support maintenance effort.

The latter terms, "direct life support effort" and "direct personality support maintenance effort" are included because of the need to extend this equation to crises situations, particularly postattack crises. In normal circumstances, these efforts are part of occupational effort and primary interaction.

The available effort equation is expressed in terms of symbols as equation 3.

(3) $AE = 91-L-VR-TT-LSE-PSE$

It is useful to change the form of expression of effort here to hours per week per man from the expression man hours per week used in equations 1 and 2. After the calculations of distribution of hourly activity for a "typical" man have been worked out, it is possible to convert to the other base for use with equations 1 and 2 as follows:

(11) $ae = \frac{AE \cdot M}{40}$

One important reason for the conversion is that in more advanced calculations we expect to break the work force down into groups, each of which will produce a different average available effort per man. Thus, available effort for the society will consist of the sum of available effort from each group.

(12) $AE \cdot M = AE' \cdot M' + AE'' \cdot M'' + AE''' \cdot M''' \ldots n$

As used in equation 3, leisure, volunteer role playing, travel time, life support effort and personality support effort are societal averages distributed as if each man engaged in each activity equally. We know that this creates an "average man" that is nowhere found in reality, but our "average man" is a useful analytical construct for our generalized analysis.

We may determine the preattack average values for each of the factors in equation 3 from Departments of Labor, Commerce and census data. In this situation, direct life support and personality support needs will be automatically satisfied by efforts in other areas and LSE plus PSE will both be zero. Average occupational travel time may absorb six hours per week with normal functioning of the systems for transporting people. Volunteer role activity will be somewhat difficult to calculate but research data developed for this project by Northwestern University will provide some basis for an estimate. We know that not all people engage in volunteer role activities. The number we will use is our best guess at the probable distributed average. Since we have already estimated the normal distributed average employment effort to consume 42 hours, we can determine the average consumed leisure per week by subtraction.

Assumed Normal (Preattack) Distribution of
Worker's Disposable Hours

AE = 42
L = 39
VR = 4
TT = 6
LSE = 0
PSE = 0

Changes in rules and laws and changes in the life circumstances of people can change the value of these factors. Postattack changes in the life circumstances of people probably alter the value of all of them. We will be interested in knowing how much available effort we can expect from each surviving able-bodied worker. If we can calculate the postattack value of each of the other factors, we can assume that whatever is left over after these values have been subtracted from 91 is the effort available from each surviving able-bodied worker.

We have suggested in earlier discussions of our model of society that circumstances are likely to arise, postattack, when people would believe that supplies for the satisfaction of life support needs were in uncertain supply and that situations might exist where people are separated from their primary group and/or are without a point of geographic reference. It is at times such as these that life support effort and personality support effort will no longer be zero. In order to deal with this in equation form, we will need to determine what these two factors (LSE + PSE) are functions of and what measurable phenomena in society might serve to indicate their value.

We assume that for persons who have access to employment and where wages have significance for consumption (the latter being an important assumption about the state of the postattack fiscal subsystem), direct effort to secure elements of life support outside of occupational effort would only occur if persons perceived the inventory of basic retail goods available for purchase or otherwise available to them to be growing steadily smaller. If we consider the change in inventory to be supply minus consumption, we can write:

$$(13) \quad \Delta_I = GS - C$$

If a large proportion of people see their portion of basic consumer goods steadily decreasing, they can be expected to respond by giving direct attention to securing the means of life support; i.e.,

$$(14) \quad LSE_{A-t} = K_I \frac{\Delta_I}{\Delta t}$$

whenever ΔI represents a decrease in basic goods inventory.

The above construct presumes that people are all receiving consumer goods on a distribution basis that they consider fair. A perceived "unfair" distribution system for disposing of basic goods and services may have the effect of exaggerating basic life support effort. The discussion also presumes that people believe in the existence of some place or situation where activities such as bartering with farmers, foraging, scavenging, or stealing will produce results. [Note:

There are many variations in culture, life circumstances, and society that will affect life support effort. We have, here, only introduced the beginning of a complex discussion.]

We can develop a similar first approximation for dealing with PSE. Direct personality support maintenance effort is the consequence of separation of members of primary groups, separation of neighborhoods and displacement of persons from a geographic place of reference. It is not unreasonable to assume that the amount of effort diverted to direct personality support maintenance will be some function of the proportion of the surviving population who are refugees. The term refugee will have to be carefully defined if a count of refugees is to be used for this purpose. This will include some method of purging the refugee lists as persons become re-established with primary relations and a geographic place of reference. This should be quite possible. Therefore, we may say:

$$(15) \quad PSE = K_{rf}R$$

The amount of time given to volunteer role effort in the postattack world may be divided into two parts. One will have a positive quality and can be referred to as volunteer service. This will not be limited to nursing the sick, but it will be related to the number of sick, orphaned and distraught in the population. We may be able to use the proportion of the population sick and injured as an indicator. We can probably develop a coefficient for use with this percentage using reasoning partly developed above. We can derive this coefficient from preattack information about how families respond to sickness.

Let
VSE = volunteer role service
K_{si} = service coefficient
SI = percent of population sick or injured

$$(16) \quad VSE = K_{si}SI$$

The other form of volunteer role activity can be considered social action activity directed toward change. Perhaps we will be overstating the case, but in order to deal simplistically here with a complex problem we will call this volunteer

role playing "agitation" and designate it VRA. We will assume that persons who play social action roles in normal times will be most frequently involved in agitation roles in crisis. We will determine VRA by multiplying VR by an agitation factor, K_{af}. We will define the agitation factor as a ratio of consumption expected to consumption received. This is the basic marketplace coefficient for Figure 1.

$$(17) \quad K_{af} = \frac{\text{supply}}{\text{demand}}$$

Determining what people will demand under various postattack circumstances will require an analytic process that we have not yet sufficiently developed. We can reasonably expect that demand will be a function of perceived supply and perceived life support requirements. It will also be related to the respect people have for managers of the supply and "marketing" system and to their confidence that these people know what they are doing. Communications from leaders to consumers that are believed in will have a positive effect on the acceptance of reduced supply which is equivalent to reduced demand.

$$(18) \quad VRA = VR_o \cdot K_{af}$$

$$(19) \quad VR_{A-t} = VSE_{A-t} + VRA_{A-t}$$

From the preattack situation evaluation we have tentatively determined leisure, preattack (L_o), to be 39 hours. We have suggested above that some rebound effect might be expected to occur as a consequence of survivors' national loyalty and their perception of an emergency. This rebound can take two forms; it can consist of willingness to work longer hours and of a practice of working harder during working hours. If people work longer hours, this effort must come out of leisure time available. If we assume that willingness to work longer hours is a consequence of people's perception of the reduced productivity of the postattack economic system and their desire to increase this productivity, we can write an expression that shows leisure as a function of the difference between preattack productivity and postattack productivity. If we continue to treat available effort as the residue after all other uses of time have been accounted for, this reduction

of leisure is actually an expression of increased available effort. The expression for leisure expectations due to decreased productivity would be:

$$(20) \quad L_{A-t} = L_o \cdot \frac{K_L}{1 + (GS_o - GS_{A-t})}$$

Transportation time is another variable that will probably change as a result of the attack. We have arbitrarily estimated average travel time per worker in preattack society to be six hours per week--TT_o. The disruption in the highway net, in fuel supply and in the rail net along with damage to vehicles and displacement of personnel is sure to increase worker travel time. We will not attempt, at this time, to pick an indicator to use in estimating increased travel time. We presume that with further analysis we can pick such an indicator and call it α.

$$TT_{A-t} = TT_o \cdot \alpha$$

If we put this all together to give us an equation for postattack available effort per man we get:

$$(3) \quad AE = 91\text{-}L\text{-}VR\text{-}TT\text{-}LSE\text{-}PSE$$

$$(21) \quad AE = 91 - (L_o \cdot \frac{K_L}{1 + (GS_o - GS_{At})} - (K_{si} \cdot SI + VR_o \cdot K_{af}) - (TT_o \alpha) - (K_I \cdot \frac{GS_t - C_t}{t}) - K_{rf} R$$

If we wish to convert this to standard (40 hour) man weeks available to the production and repair processes, we can write:

$$ae = \frac{AE \cdot M}{40}$$

We are not, at this point, in a position to equate available man weeks to usable effort, however. Usable effort is defined in terms of 40 man hours of work by persons with appropriate skills, experience in working together and consequent good communication, and with standard peace time work motives. The man weeks of available effort for the postattack situation are not necessarily equivalent in

hourly productivity. We can apply several productivity coefficients to ae to convert to equivalent ue. We have already accounted for the loss in productivity due to material damage by revising $\frac{GS}{ue}$. The factors we will account for now are social and psychological factors.

There are three social and psychological types of factors that we will consider in converting available effort (ae) into equivalent preattack work weeks of effort (ee). One, and perhaps most important, is worker motivation. This is divisible into several coefficients, each accounting for an aspect of postattack life that will affect worker morale. Our list is suggestive rather than inclusive. The second is the communications factor and breaks down into two parts; the first is the factor representing communication within work teams; the other represents communication between the people and the leadership. The third factor accounts for decreased productivity due to the necessity for skill substitutions in the production and repair process.

The general form of the expression for converting available effort into equivalent effective effort is:

$$(2) \quad ee = ae \cdot Z \cdot C \cdot Y$$

Z = composite of motivation factors
C = composite of communication factors
Y = skill substitutions factors

Z includes:

Z_1 = post-disaster shock
Z_2 = post-disaster frustration-aggression
Z_3 = billeting or privacy factor
Z_4 = separation from family
Z_m = utility of wages factor
Z_{ss} = perceived societal stability factor

(The above factors are all less than one in the postattack situation.)

Z_{BB} = rebound effect due to loyalty and social concern

Z_{SP} = perception of role significance, factor.

(The latter two factors are greater than one in the immediate postattack situation.)

Most of these factors are a function of time since the attack.

Some discussion of these factors has appeared above. We have done an analysis of the literature where these factors are discussed and have some rough estimates as to what values should be assigned to these factors. The values presented are tentative and may be significantly revised as a result of subsequent investigations. The analysis presented above has been on the basis of an overview of society. We have not broken down the considerations of effort or of demand on a social group by social group basis. We would insist on performing any actual analysis on a group by group basis rather than on this gross generalized basis. The gross generalized presentation is for illustrative purposes only. When it comes time to assign values to Z components, we must break down the analysis into various disaster-related groups as well as social groups. For example, before we can assign a post-disaster shock coefficient to overall effective effort analysis, we must know what proportion of the population have experienced the near miss phenomenon. We can identify a Z_1' for those who have experienced a near miss and determine Z_1 by dividing Z_1' by the percentage of survivors who have experienced a near miss. Similar considerations apply to Z_2, Z_3, Z_4, Z_{ss} and Z_{SP}. It may not be unreasonable to try to develop a protocol for identifying Z_m and Z_{BB} as factors directly applicable to system-wide analysis.

We estimate:

$$Z_1' = (1 - \frac{1}{t})$$

$$Z_2' = (1 - \frac{GS_o \cdot t}{\int_o^t GSdt})$$

$$Z_3' = (1 - .05)\frac{t}{4}$$

$$Z_4' = (.90)$$

$$Z_{ss}' = (1-K_{ss} \cdot \frac{20}{\text{average days in same occupational role per worker}})$$

$$Z_{SP}' = 1.35$$

Thus, depending on postattack productivity and the number of survivors in each attack-related social category, postattack effective effort might be greater or less than available man weeks of effort would suggest, but it will probably be somewhat less. Repair and production both make demands on effort; production is a function of production effort and the productivity factor; the productivity factor is a function of accumulated repair effort and effort in general is a function of productivity, social stability and the life circumstances of the people. In this context, the postattack period, as described by our equations, could constitute a period of marginal stability at some new and lesser level of per capita consumption, a period of growth and recovery from some new and lesser level of consumption, a period of decrease before increase in per capita consumption, or even a period of running down of the system. The consequences depend on the various coefficients and quantitites in the system as represented in the equations. Considering that the productivity of the means of production will be surely reduced and that new effort demands such as repair, burial, health care and greater attention to systems management will be imposed on the system, it seems most likely that postattack production will be more labor intensive than preattack production. It also seems that postattack production will be labor limited. Since the effectiveness of effort depends in part on how well the system is managed, it seems that planning for postattack management should get careful attention.

It is possible to take the equations listed here, and with a determination of coefficients and a judgment regarding postattack management decisions about division of effort between production and repair, to solve for the level of consumption available to a population at any particular time after an attack. The equations lend themselves to several other forms of manipulation such as determination of the optimum distribution of effort between production and repair for the achievement of a specified societal goal. They may be of some limited use at this time for such calculations.

Unfortunately there is a great deal of uncertainty associated with the determination of the various coefficients, and many of the equations are only untested hypotheses about the relationships between people and things and people and people. Furthermore, much important incomplete analysis is hidden in assumptions. For example, we have assumed that money would continue to have meaning for obtaining goods and services in the postattack world. This is an assumption about the functioning of the fiscal subsystem and the retail market subsystem that is vastly oversimplified. Some detailed modeling of these subsystems is needed for meaningful inclusion of the money-wages-consumption relationship in the model.

What we present here is therefore the first report on the development of a new tool that may be useful in defining societal problems and in planning a systematic approach to their solution. Since the disruption of society due to a nuclear attack is an almost overwhelming social problem, the development of a family of contingency plans, a management information system to manage society along lines of optimizing chances for recovery is a great challenge. We believe the tool discussed here can be useful in meeting this challenge.

V. AN ILLUSTRATIVE EXAMPLE OF USE OF THE EQUATIONS

A. Introduction

The utility of the model as represented in equation form and the limitations of the current set of equations are both demonstrated in the following example, a hypothetical analysis of postattack bility of our societal system. For simplicity, it is developed at the highest level of generality with no breakdown of people into status or disaster-related groups. It is an example of how a much more sophisticated analysis might be carried out; it does not, in itself, yield results that have quantitative significance. It does show the probable relative importance of various factors to post-crisis societal viability.

The analysis begins with one basic assumption: In the postattack situation production and distribution of goods and services will be limited by the availability and adequacy of labor. This presupposes that after a typical nuclear attack the surviving stock of capital goods and the available natural resources will be such that there is "a tool"[9] and something to work on for every survivor willing and able to exert effort. This does not presume that the "tool" is of the same quality and therefore capable of the same productivity as the comparable tool available in the preattack situation. The quality of the tool must be determined by use of a damage assessment protocol. Nor does the basic assumption presume that the willing and able workman necessarily has the skill and motivation that a preattack worker at the same task might have. This is a subject of discussion within the analysis.

This assumption deals with the relationship of labor to capital goods. It does not deal with the adequacy of the labor force for the production of goods and services necessary for survival and viability. It does not assume that survival

[9]The term "tool" is used in the broadest sense to apply to any artifact that a workman might employ and includes a ledger and a set of records as well as a hammer and a lathe.

and viability are labor limited. Whether or not they are is exactly what the analysis presented later in this section attempts to determine. All that is assumed is that in the process of mixing capital goods and labor in the postattack situation, the labor supply will be exhausted before the capital goods supply is exhausted. It may very well be that there is a surplus of labor from the standpoint of producing enough goods and services to sustain viability even though the output of the production process is labor limited rather than capital limited.

The assumption is not necessarily valid for all attack possibilities and attack readiness postures. If hardened shelters were provided for and occupied by all people prior to an attack, the great damage to capital goods and very limited death rate in the population would yield a situation where capital supply rather than labor would limit production. The assumption discussed here is important because it focusses the analysis at one type of upper limit of achievable viability. If postattack productivity were limited by the availability of capital goods, it would necessarily be less than if it were labor limited. The idle workers could be producing something if they had tools to work with.

The assumption is an oversimplification. The availability of capital goods and the quality of these goods for producing consumer goods and supporting consumer services will vary greatly from location to location. A zone by zone analysis or a region by region analysis would be more meaningful than an overall societal analysis, but such analysis would greatly complicate the example.

Societal viability will be judged in the following discussion on the basis of two values. Firstly, viability will be judged to exist if the production system can produce enough goods and services to sustain the survival of the people who have escaped death from direct effects of the nuclear attack. Secondly, viability will be judged to exist if the societal system can produce satisfactions for the survivors such that they are motivated to give sufficient effort in the form of occupation and volunteer role playing to sustain the functioning of the societal system. Only when both conditions exist is the society judged to be viable.

The conditions of viability specified above are interdependent and are functions of time. A society might survive for a period out of preattack inventory

and then reach a condition where one or both conditions of viability disappeared because of the exhaustion of the inventory. On the other hand this society, surviving partly off inventory, might develop, in the period of inventory depletion, the means to sustain itself in a viable fashion after the inventory is exhausted.

The discussion will not attempt to assess viability in absolute terms. It will be limited to discussion of the effect various factors have on the probability of achieving viability.

B. The Example

The three basic equations to be used are:

(1) $GS = \frac{GS}{ue} \cdot ue$

(2) $ee = ae \cdot Z \cdot C \cdot Y$

(3) $AE = 91\text{-}L\text{-}VR\text{-}TT\text{-}LSE\text{-}PSE$

The term $\frac{GS}{ue}$ is the productivity coefficient of the production network of the society. It is the generalized representation of what capital goods, organized in the form of the production network, can contribute to output when combined with appropriate raw materials and appropriate skilled labor. A simplified way for deriving this coefficient would consist of dividing yearly personal consumption expenditure by the number of persons in the labor force and then correcting to a weekly productivity basis. Thus, if it is assumed that the yearly personal consumption is at the rate of $490 billion and that there are 70 million people in the labor force, each of whom works on the average 50 weeks a year at forty hours a week, $\frac{GS}{ue} = \$140$ (i.e., $\frac{49,000,000,000}{70,000,000} = 7,000$ and $\frac{7,000}{50} = 140$).

In the postattack situation capital goods will be damaged and destroyed. Centers of production will be rendered less effective due to direct damage to equipment and further limited by damage to transportation and communication linkages that connect these centers to one another. The postattack productivity coefficient of capital goods ($\frac{GS}{ue_A}$) will be less than the preattack productivity coefficient ($\frac{GS}{ue_o}$).

Under the assumption used here, that there will be plenty of capital goods available for use, the reduction in the productivity of this capital goods has a direct multiplying effect on the amount of consumer goods that can be produced for postattack society (i.e.: $GS_A = (\frac{GS}{ue_A})\, ue_A$). It was noted in the previous chapter that a protocol for estimating this factor for the postattack world must be developed. It was suggested that network analysis seems to be the most reasonable way for developing this protocol. It is beyond the scope of this analysis to develop this protocol or to arrive at an estimate of postattack capital goods productivity that can be taken seriously. Information from postattack input-output analysis of the production process and damage analysis of particular industries suggests that a reduction of productivity of at least one-half in the immediate postattack situation might not be unrealistic.[10] (I.e., if preattack $\frac{GS}{ue_O} = \$140$, postattack $\frac{GS}{ue_A} = \$70$.)

The value of goods and services produced in and for postattack society is an important factor for solving equations 2 and 3. At the same time, equations 2 and 3 yield the value of the effective effort that can be used as utilizable effort (ue_A) to produce goods and services. Simplified applications of the equations can be accomplished if $\frac{GS}{ue_A}$ and ue_A are assumed and then ue_A is solved for in an iterative process. For purposes of this example, it will be assumed that productivity in the postattack situation is half the productivity of the immediate preattack situation. It will also be assumed that the ratio of standardized forty-hour work weeks worked to the number of persons in the total population will remain the same after the attack as it was before. Under these circumstances, if each surviving workman worked, on the average, the same standardized work week with the same effectiveness that he did before the attack, and this effort were divided up in terms of administration, repair, capital goods production, and consumer goods production in the same way as it was preattack, the postattack per capita gross national product would be one-half the value of the preattack per capita gross national product. The output figure, corrected on a per capita basis, provides an important factor for the calculation of available effort. The available effort must be great enough to provide the forty

[10] A generalization derived from network considerations and such studies as "Nuclear Blast Effects on a Metropolitan Economy" by William C. Truppner, IDA (September 1965), OCD-OS-63-134.

hours of effective productive effort per surviving workman assumed in arriving at this figure if the figure is really usable. As noted above, iterative analysis provides a means of refining or correcting this estimate.

Available effort (AE) is the term used to designate the number of actual man hours per workman available for application in the production process. Equation 3 provides the analytical framework for deriving this number. Calculations of available effort per man (AE), and available actual man weeks (ae), do not take into consideration the quality of this effort. The quality of actual man hours available is dealt with in equation 2. The logic implicit in this use of this family of equations requires that available man hours be calculated first and that after this calculation is performed, a correction be made in terms of the quality of these available man hours. Corrected or standardized man hours available in the form of standardized (40 hour) man weeks is the term assumed for equation 1 and to be solved for in an iterative process.

Equation 3 states:

$$AE = 91\text{-}L\text{-}VR\text{-}TT\text{-}LSE\text{-}PSE.$$

It has been assumed in the previous chapter that leisure preference (L_o) normally accounts for 39 hours of a typical workman's week. If there is to be any increase in available effort per workman in the postattack situation, it will have to come largely from his giving up of his leisure time. It has been assumed in the prior chapter that willingness to give up leisure time is a function of change in available consumer goods and services. This was expressed in equation form by equation 20.

$$(20)\quad L_{A\text{-}t} = L_o \cdot \frac{K_L}{1 - (GS_o - GS_{A\text{-}t})}$$

On the basis of the assumptions made above and with the two goods and services terms (GS_o and $GS_{A\text{-}t}$) both corrected to a <u>per capita</u> basis, the equation written for the example being developed becomes:

$$L_{A\text{-}t} = 39 \cdot \frac{K_L}{1.5}$$

If K_L is assumed to have the value one (1), then, in the example situation, leisure time will drop to 26 hours per week (i.e., $L_{A-t} = 39 \cdot \frac{1}{1.5} = 26$). The effect of decreasing goods and services available to consumers by one-half is presumed to create a willingness to work or to employ in activities other than the enjoyment of leisure 13 additional hours a week.

The use of an equation to produce this conclusion does not change the fact that this is an assumption. A careful analysis of the processes in which leisure preference develops has not been performed. This work awaits the further analysis to be attempted subsequent to this report. At this point an educated guess is necessitated. Such guess work suggests that the 13 hour increase in disposable effort is not unreasonable but that the figure might go as high as 26. Considering that the term leisure has been used here to include everything but working, eating, sleeping, work travel time, and role playing in volunteer organizations, it seems unlikely that it would be cut by more than two-thirds under the circumstances of this example.

The hours of effort that become available as consequence of workers' renunciation of leisure will not all be utilized in increased occupational effort in the postattack situation of the example. The time required for workers to travel from their geographic point of reference to their place of employment will increase. The protocol for developing a coefficient (α) to use in correcting transportation time effort has not been developed, but it does not seem unreasonable to expect work-related transportation time to double as a consequence of nuclear attack. This would reduce the available effort from each worker by six hours per week.

The assumptions for this first iteration presumes that per capita production of goods and services will be cut in half as an immediate consequence of the attack. In the immediate postattack situation, consumption of goods and services might well exceed this figure with a consequent reduction in consumer goods inventory. Equation 14 expresses a hypothesized relationship between a decrease in consumer goods inventory and an expenditure of effort by workmen in direct quest of life support needs. It is assumed that direct quest of life support needs (LSE) is zero in the preattack situation. Actual effort that provides for life support is a small undifferentiated portion of social life in the preattack world. It does not

seem unreasonable to guess that, in the face of a substantial decrease in productivity and a related shrinkage in consumer goods inventories, workmen would, on the average, devote four hours a week to deliberate, easily identifiable life support effort. Allowing an average of little more than half an hour per day for workmen to devote to bolstering their personal food supply in the wake of nuclear attack seems reasonable--perhaps conservative.

Preattack personality support efforts are lost in the undifferentiated flow of other efforts as are life support efforts. Equation 15 hypothesizes that average postattack personality support effort (PSE) is a function of the proportion of the population who are refugees. Following this line of reasoning, it might be assumed that after the attack, 25 percent of the population will be refugees. It might also be assumed that the average refugee will devote 20 hours a week to try to fully establish personality support relationships. This is equivalent to assigning a value of 20 to K_{rf} in equation 15. Solving equation 15 with these assumptions yields:

$$(15) \quad PSE = K_{rf}R$$
$$= 20 \cdot 0.25$$
$$= 4$$

Because the role definition of nurse in our society emphasizes this as a woman's role and because women constitute only a fraction of the normal work force, it is unlikely that the volunteer role playing that involves care for the sick and injured will absorb a great deal of the effort otherwise available for occupational role playing. It may not be unreasonable to guess that on the average, one hour a week per available workman will be absorbed in such effort.

As a conservative estimate, it will be assumed that there is no time increase in volunteer role playing due to an agitation factor, but that social action volunteer role playing continues to absorb, on the average, four hours a week.

This discussion has followed equation 3 through with a postattack derivation of each of its factors. The basic assumptions applied to the equation yield the following results:

(3) $AE = 91\text{-}L\text{-}VR\text{-}TT\text{-}LSE\text{-}PSE$

$$L_A = 26$$
$$VR_A = 5$$
$$TT_A = 12$$
$$LSE_A = 4$$
$$PSE_A = 5$$

$$AE = 91 - 26 - 5 - 12 - 4 - 5$$
$$AE = 39$$

There has been no deliberate effort exercised here to arrive at any particular AE figure. "Best guesses" have been used for determining each factor. The product of applying these best guesses to equation 3 does suggest that in the postattack situation the effort made available due to a willingness of workers to give up leisure might be just absorbed by the new demands circumstances imposed on their time.

The most uncertain of the particular guesses dealt with workers' willingness to give up leisure time. In the discussion of the model in Chapter II, it was noted that Social Life is hypothesized to be an end in itself and not an adjunct to societal process. Social Life goes beyond the satisfaction of basic personality support needs to the providing of the pleasures of interaction and the processes of participating as consumers in the normal marketplace. Men may, in the dire circumstances suggested by the assumptions of this example, be willing to give up much more of this time than was assumed. If the amount of leisure time surrendered due to the dire social circumstances is double that initially assumed (i. e., 26 rather than 13 hours of leisure are given up), and no other assumptions are changed, available effort would become 52 hours per average worker per week. This figure may represent the upper limit of average available effort per workman a postattack planner or manager might reasonably expect.

This available effort cannot necessarily be equated to utilizable effort. Firstly, there is the management decision that has to be made regarding the desirability of foregoing some immediate production for the sake of increased future

productivity. Any effort that is assigned to the repair category (i.e., (rep) in equation 6) must also come out of the total effort available. Secondly, the productivity of a typical workman's hour in the postattack situation may be different from the productivity of a typical workman in the preattack situation. The utilizable effort term (ue) is standardized for the preattack situation. Equation 2 is designed to convert available effort (ae) into standardized effective effort (ee) from which repair effort (rep) and production effort (ue) can be drawn (see equation 3, ee = ue + rep). In equation 2 the effects of postattack changes in motivation and communication and the effects of postattack skill substitutions are introduced into the analysis.

Use of equation 2 currently involves the same kind of guess work as that resorted to in the use of equation 3 above. At the same time, as in the case with equation 3, this approach allows for specific identification and quantification of the guesses being made and for an identification of how significant each may be for the conclusions developed.

Equation 1 is the basic equation of the Production Network as indicated in Figure 1. The quality of the production process with all its complexity is reduced to the productivity coefficient for simplification. Equations 3 and 2 deal with the People aspects of the diagram in Figure 1. Terms of equation 3 can be related to this diagram. Available effort (AE) is the output of the People subsystem that goes to the Occupational Role Skills Pool. Leisure (L) is the output of the People subsystem that goes to social life and it also includes the effort expended in market activities of people as consumers. Volunteer Role Effort (VR) is the ouput of the People subsystem that goes into Government and Social Action where institution building takes place. Some occupational effort also is absorbed in Government and Social Action; it is assumed that such occupational effort indirectly contributes to productivity in this simplified analysis.

The terms for direct life support effort (LSE) and direct personality support effort (PSE) do not have a reference point on the diagram because they refer to effort that is taken out of the system. In normal times they are zero. When there is a dislocation in the consequences of normally motivated behavior for

serving basic needs, people, to a degree, withdraw from the system to seek personal survival as small primary groups. Thus LSE and PSE designate effort that cannot be represented in a system diagram because it is effort lost to the system.

It is a consequence of indications from the marketplace that triggers direct life support effort (LSE). A similar signal from the marketplace is assumed to control leisure preference and thus leisure effort (L). A feedback through the satisfactions system is presumed to control volunteer role playing effort in terms of both quantity and direction. Transportation time is assumed to be a derivative of the state of the system's artifacts and direct personality support effort derives from a direct dislocation in the people system (stratification system as represented in Figure 2) itself.

Equation 2 deals with the effects of the attack on the institutional system, on the satisfactions feedback from the marketplace, on the direct effects of attack on personalities and on the direct effects of attack on population composition. The general form of the equation is:

$$(2) \quad ee = ae \cdot \not{Z} \cdot C \cdot Y$$

The term Y refers to the change in quality of available effort derived from the necessity of skill substitution. In the analysis developed in Appendix A, which deals with the social and psychological aspects of the problem of repairing a specific power station as a contribution to reestablishing linkages in the production network, the need for skill substitution in repair effort is suggested. It seems quite likely that, given the assumption that population loss will probably occur in a cross-sectional fashion, skill substitution will be of more significance in repair efforts than in production efforts. The reasoning behind this statement is that if surviving skill groups exist in the same proportions though in reduced numbers as in the preattack world, production processes that can be easily reactivated will have available a skilled labor force proportional to the relative postattack need for their product. On the other hand, repair requirements impose a new level of requirements for skilled effort. Repair effort will necessarily exceed normal maintenance installation and repair effort and will thus create requirements that exceed proportionally available supply. The need for skilled boilermakers to repair damaged

power plants is likely to far outstrip the survivors of the 23 thousand boilermakers in preattack society. If one notes that about half of these boilermakers are involved in building new boilers and therefore concentrated in a few locations while the repair needs will be spread throughout the country, the problem of skill location and skill substitution takes on an added complexity.

The example in Appendix A suggest the kind of management protocol that must be worked out if renewed production and repair is to be done with some efficiency. The value of the skill substitution factor is dependent on the degree to which such management is exercized and can be derived, in practice, only from an analysis of various types of labor performance beyond the scope of this particular research. Skill substitution effects are a consequence of the intrusion of the attack into the societal system and on the amount of preattack planning for postattack management that has been done. It seems reasonable, in light of the above discussion and the discusssion in Appendix A, to expect an overall loss in effectiveness of effort due to skill substitution of at least ten percent. Therefore, for purposes of this example, the overall skill substitution coefficient (Y) will be assumed to be 0.9.

The communications coefficient (C) is a composite. One aspect of communications that will be reflected in effectiveness of effort developed by work groups is communications among particular group members. To the extent that members of a work group know each other from the preattack period and have some experience working together, they will be able to communicate well and develop cooperative effort. To the extent that members of postattack work groups are strangers to one another and/or have little experience working together, they will have initial difficulties developing communication and cooperation. Demographic analyses performed so far suggest that though the overall composition of the population will probably remain unchanged, there will be a substantial disruption in the smaller, more primary groups of the society. One indication of this is found in the predicted substantial increase in orphans in the society. It therefore seems reasonable to assume that there will be some overall decrease in effectiveness of available effort due to problems of communication within work groups.

Another aspect of communication has to do with the stability and meaning of the traditional signs and symbols of the culture as used by leaders for communication with the people. In Chapter II, the somewhat complex relationship between a symbol and typical behavior was noted and illustrated with a discussion of the "Stop Sign Experiment."[11] Each symbol exists within a context of life circumstances of the people of the society. As life circumstances are changed, the symbols and the related rules and laws become less obviously relevant to individual and social well being. Yet people have a great need for the security of reliable signals derived from stable meanings of symbols. Uncertainty with regard to symbols creates anxiety and is widely believed by sociologists to be a major factor in contributing to development of riots. The loss of effectiveness of symbols due to changes in life circumstances of people--i.e., loss of familiar transaction partners, loss of artifacts that have utility and symbolic meaning, loss of broader social linkages, etc.--has two effects. One is a direct effect on the effectiveness of communication between leaders and people. The other, to be further dealt with below, is a direct effect on morale.

The loss of effectiveness of symbols for communication can be thought of as a reduction in the degree of conforming behavior. This will probably not be pronounced with regard to the more familiar everday symbols such as the right to authority in many matters communicated by the policeman's uniform. People will do everything they can to maintain social stability in their immediate environment. However, communications from some distant leader directing atttention to an activity that does not have obvious immediate important consequences will probably be responded to with less than typical enthusiasm. This will decrease the effectiveness of available effort and will only be overcome when the organization of leadership and the rules and laws that manifest the institutions are drawn back together into a demonstratably effective system. It is not yet possible to present a derivation of this aspect of the communications factor in the form of an equation. This must wait on a more detailed modeling of the social-cultural interchange. However, it is not unreasonable to suggest that this effect will be significant. The overall

[11] See pp. 21-22.

reduction of effectiveness of effort due to communications difficulties will probably substantially exceed ten percent and assigning a value of 0.9 to the communications factor (C), as will be done for this example, is probably taking an optimistic position.

The motivation correction factor (Z) is even more of a composite than the labor substitution and the communications correction factors. It includes one group of factors, exemplified by Z_1 and Z_2, that account for effects on motivation due to persons' experience during and immediately after the attack. Another group of factors, exemplified by Z_3, Z_4 and Z_{SP}, account for the effect on motivation caused by changes in social practices directly necessitated by the attack. Still another set of factors, exemplified by Z_m and Z_{ss}, account for the effects that changes in the implications of symbols, rules and laws, and related organizational structure and functioning will have on motivation. A last factor, Z_{BB}, attempts to account for the effects loyalty to one's own societal system will have on motivation in the postattack situation.

An attempt has been made to state, in equation form, hypotheses about the relationship of these factors to some indicators.[12] These hypotheses presume that several of these factors have values that are dependent on the length of time that has elapsed since the attack. The hypotheses are developed with reference to the concept that each factor applies to a large group of people in the society, but not to the whole society. For example, it is presumed that the post-disaster shock coefficient applies only to people who have experienced the near miss phenomenon.

Time since the attack has not been introduced as a factor in the example being developed here. Sophisticated analyses of viability will require an analysis of postattack society as a developing societal system in time; however, this sophisticated analysis lies outside the time limits of this research. It is therefore necessary to make some crude guesses about the average values of these coefficients in the weeks immediately following the attack for this example.

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[12] See pp. 55-56.

Disaster literature, particularly that derived from analyses of civilian populations in World War II, suggests that there will be some shock and post-disaster frustration aggression effects. The shock effect will decay relatively quickly and the frustration aggression effect may not be great. It seems reasonable to guess a value of .98 as the product of Z_1 and Z_2.

The same body of research and analysis suggests that definite and persistant annoyance effects will emerge from dislocations such as billeting and the separation of workmen and their families. At the same time, many people will perceive their roles in the postattack situation as having increased importance and will be positiveiy motivated to intensify their efforts. For lack of good reasons to do otherwise, it will be assumed here that these two effects cancel each other.

It will be assumed that loyalty to the societal system will have a strong positive motivational effect, most intense where the most damage has been experienced, but on the average, adding a 15 percent improvement in motivation; i.e., $Z_{BB} = 1.15$.

Noting that Z_m and Z_{ss} have not yet been taken into consideration, it is useful to combine all other correction factors ($C = .9$, $Y = .9$, $Z_1 \cdot Z_2 = 98$, $Z_3 \cdot Z_4 \cdot Z_{SP} = 0$, $Z_{BB} = 1.15$). The result yields an overall correction factor, exclusive of Z_m and Z_{ss}, of 0.91. Application of this coefficient in equation 2 to the available effort yields the following results:

$$\frac{AE \cdot M}{4} = ae \frac{39 \cdot M}{40}$$

$$ee = \frac{(39 \cdot M)}{40} \cdot 0.91 = 35\ 1/2$$

This suggests that according to the assumptions of the example and neglecting Z_m and Z_{ss}, there will be available from each surviving, able worker in the postattack situation, effort equivalent to 35 and one-half hours of work by a typical workman in the preattack situation. If the more optimistic figure, AE = 52, discussed above, is used, then $ee = \frac{47\ 1/3 \cdot M}{4}$. Considering the uncertainties involved in the assumptions, the original guess of UE = 4 is validated if it is assumed that no repair is attempted.

This last assumption is untenable in light of such obvious problems as clearing rubble out of roadways, collecting, transporting, and housing displaced persons and burial of the dead. It is not unreasonable to guess, however, that temporary discontinuation of such functions as teaching school, entertainment and the like might free personnel to accomplish these basic tasks. The assumption remains that no major system repair can be immediately attempted. Under these circumstances the value of $\frac{GS}{ue_A}$ in the immediate postattack situation appears to be crucial. If it is sufficient for survival, it will probably also provide motivation for sufficient occupational and volunteer role playing to sustain itself. Capital growth will be low and at a rate proportional to consumer goods production.

The actual picture is not as rosy as this. Throughout the summation in the last few paragraphs, the motivational effects derived from the utility of wages and perceived social stability have been neglected. It can be reasonably argued that both will be significantly less than one.

Though it is carried on a sea of assumptions, this working through of the equations within the constraints of the conceptual model has led to a conclusion. Societal viability is precarious in the wake of a major nuclear war. It seems to illustrate the potential utility of the model even if the conclusion is uncertain. The assumptions used can be substantially refined through indicated extensions of the modeling effort and through empirical analyses of contemporary society. Thus a somewhat more secure conclusion is achievable.

The conclusion suggested above is specifically this: If the preattack fiscal system and other evidence of societal stability cannot be sustained in the postattack situation, our society may well fall apart and reemerge only in some different form with a substantially reduced standard of living for all. By virtue of the basic definition of viability presented in the introduction to this report, this would mean the society was not viable and, by definition, no matter what happened to the adversary, we would have lost the war; we would have lost the value structure we presumably entered into nuclear war to preserve.

The reasoning leading up to this conclusion is as follows. On the basis of the assumptions made, neglecting the effects of Z_m and Z_{ss}, the society might

survive and remain viable but there would be a reduction by at least half in per capita production and consumption of goods and services and a slow rate of capital growth involved. In short, there would be little margin for error or room for disruptive social practices. If, under these circumstances, workers could not perceive of wages as having present or future utility for purchase of goods and services, and if they perceived the leadership to be unable to provide accurate prediction and a basis for stable expectations for the future, their motivation to exert effective effort would be substantially undermined and survival level productivity would become a real problem.

This is not a prediction. It is not at all clear that the example is sufficiently grounded to lead to valid conclusions. It does suggest this. Efforts to develop contingency plans, a management information system, and a management system, all in some detail, for use in the postattack situation would be a very good investment of preattack time and energy. The probabilities of utility for such a system seem high.

The contention to be proposed in conclusion of this chapter is, therefore, that the conceptual model with the diagram and the equations can be of utility for identifying the role and importance of social and psychological factors in societal functioning and particularly in crises situations. One method for so utilizing the model has been illustrated.

In the illustration the question that was asked was, under a certain set of assumptions about the effects of a nuclear attack, will the postattack society be viable. The analysis focussed on the effects of social and psychological factors on postattack viability. It was shown how different social and psychological factors, whose strengths are changed as a consequence of the attack, combine to reduce the postattack available labor and the productivity of available labor and thus reduce the probability of societal viability. The approach permits a more accurate prediction regarding postattack viability as the values used as coefficients are more accurately determined. The analysis does suggest, in its present form, that postattack societal viability is precarious and that preattack measures designed to help prevent the postattack deterioration of important social and psychological factors are strongly indicated.

VI. CONCLUSIONS

The degree of progress documented in this report demonstrates that a systems model of society can be developed. Contemporary social science has provided the basis for formulating the model in conceptual terms. This conceptual model can be represented in diagrammatic form, and the systems analysis approach makes it possible to represent the model in the form of a family of equations. The conceptual model, diagram, and family of equations presented here form a beginning. Carrying the development this far suggests what a more fully developed model will be like, how the fuller model can be developed, and how models of society can be used as tools for dealing with social problems.

The model in its present state points out how and where social and psychological factors enter into the functioning of the societal system. The equation form of the model provides a means whereby social and psychological factors can be introduced into societal analysis in quantitative form.

The model calls to the analyst's attention those social and psychological areas most vital to effective societal functioning. The problem of developing quantitative indices for factors in these areas is thus raised. Such quantification is possible and the means for developing indices are at hand, but the practice of developing these indices is new; the information needed for developing such indices is either buried in social science research literature and data files or is nonexistent. The preliminary efforts to establish such indices, presented here, reveal an approach to solving this problem and some of the difficulties involved. Only in the wake of the development of the model of society is it possible to be clear as to what data is needed and what hypotheses need to be tested. Now that model development is underway, development of indices for social and psychological factors for use in the model can proceed with good chances for success. An organized review of existing social science literature and some new empirical research will be needed. The attempts to develop such indices presented here can point the way toward a much fuller development.

Application of the model in its present state to the question of what are the necessary and sufficient conditions for societal viability delineates some areas in which social and psychological factors are important. Variations in leisure preference, motivation, communication, etc., directly affect system functioning and feed back on themselves. The perceived legitimacy of institutions is crucial for survival of a society. Detailed modeling attention to the institutions-organizations aspect of societal structure is indicated as being a desirable next step in this line of investigation.

The analysis of societal functioning in crisis has proceeded far enough to suggest that in the event of a very serious crisis such as a nuclear war, the degree to which contingency plans, a management information system, and a management system for the post-crisis situation have been adequately planned and developed prior to the crisis may be decisive in determining if the society will survive. These contingency plans and management plans depend in large part for their adequacy on the use of a conceptual model of what society is, what indicators of primary societal functionings are, and how leadership can intervene into disorganized societal situations to provide a basis for order. The model that provides a basis for more clearly identifying these problems is also a necessary tool for developing solutions. One major application of the model of society, then, can be as a tool for guiding the development <u>now</u> of contingency plans, a management information system, and a management system for use in the postattack situation.

APPENDIX A

AN ILLUSTRATIVE EXAMPLE--REESTABLISHING AN ELECTRICAL POWER GENERATION PRODUCTION LINKAGE IN A METROPOLITAN COMMUNITY

AN ILLUSTRATIVE EXAMPLE--REESTABLISHING AN ELECTRICAL POWER GENERATION PRODUCTION LINKAGE IN A METROPOLITAN COMMUNITY

The model of society and the equations we have developed are directly applicable to society as a whole. An analysis at the same level of generality might be applied to a region or zone or to a particular community. At each level where societal management takes place, systems analysis of society and the development of contingency plans is desirable. Not only is a metropolitan community area of half a million people just as susceptible to such analysis as the entire American society; in an actual postattack situation, national analysis would necessarily have to be built up out of regional and community analyses.

A. The Hypothetical Situation

For purposes of illustrating application of some aspects of our work, we will focus analysis on a hypothetical metropolitan community of 400,000 that happens to be served by one 600 megawatt power plant. This community has suffered a direct attack and the power station has received nine psi overpressure but no fire damage. The power plant is a basic link in the production process for all manufacturing effort in the community. Without specifying just what the relationship is, we note that labor productivity $(\frac{GS}{ue})$ is a function of availability of electric power. Not only does electrical power input involve over five percent of total input for basic metal, glass, paper, and chemical production, it plays a crucial role in all production. The development of a system for identifying labor productivity in various contingency situations would include a systematic statement of the relationship between productivity and available electrical power. This suggests that, in the metropolitan community in question, productivity will probably be limited to some low value until the electrical power generating plant is put back into operation. One of the linearities assumed in the discussion of mathematization above, is already called into doubt. Repair of an electrical power generating plant is not something that produces increased output a little at a time. Repair effort can be

exerted in the repair of a power plant for several months before any consequences for increased productivity occur. A repaired power plant is almost like a pregnancy; it either is or it isn't. Thus, a substantial amount of repair effort will have to be exerted before an improvement in productivity occurs. When this improvement occurs it will come about in step-function fashion.

The crucial question is, how long does it take to repair the power plant? The answer, as is partially illustrated below, is anywhere from five months to three years. These are the figures that emerge when we consider only the quantity and quality of the labor involved in the repair effort. Disruptions in linkages between the power plant and other industry could create difficulties in obtaining the necessary supplies and equipment to effect repair and delay the process even longer.

This analysis is particularly concerned with direct effects of social and psychological factors on the production process. Therefore, the discussion is focussed on repair limitations emerging out of the limited quantity and quality of labor. Both labor quantity and quality are strongly affected by social and psychological factors.

Labor productivity is considered to be a prime consideration in planning for postattack repair and recovery. This study provides an initial view of some of the more important factors which are believed to have important consequences for labor productivity in the postattack period.

The study proceeds from a repair analysis of an electric utility system developed elsewhere. Since present concern is for the labor repair requirements of the utility system, the system itself is taken as datum. One particular occupation--boilermaker--is examined in detail, to determine how total repair time might vary by introducing into the basic repair model various assumptions pertaining to the availability and productivity of labor under certain conditions. One set of variants to the basic model consists of changes in the scheduling and intensity of work performed by appropriately skilled labor, and the possibile effects of such variants on labor productivity. A second set of variants pertains to the substitution of skills in the performance of a specific repair task, ans the possible effects on

labor productivity associated with the utilization of less-than-optimally skilled labor. A third set of variants deals with a set of socio-psychological factors stemming from postattack stress which affects labor productivity.

B. Manpower Requirements for Repair of Electric Utility System: The Basic Model

The repair model utilized in this study was developed elsewhere.[1] A description of the electric utility system upon which the analysis in this report is based appears as Tab A, below. The system's physical configuration and postattack damage loss are of less importance here than the implications of the manpower requirements for repair of the system.

Assumptions of the Basic Model

The following assumptions were incorporated into the basic model.[2]

1. Manpower Skills: All repairs are performed by skilled repair personnel using the equipment, supplies, and facilities normally available under preattack conditions.

2. System Restoration: The repaired system provides at least 90 percent of the preattack design performance, but might not incorporate the same design, require the same operational inputs (manpower, energy, or materials), or provide the same longevity.

3. Other:

   (a) No unusual environmental conditions (inclement weather, frozen soil, flooding, high groundwater table, fallout radiation, fires, or remote or inaccessible location) are present to interfere with the repairs.

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[1] W.H. Van Horn, G.B. Boyd, Carl R. Foget. "Repair and Reclamation of Gas and Electric Utility Systems." (Burlingame, Calif.: URS Corporation, July 1967). (Prepared for Stanford Research Institute)

[2] Ibid., pp. 3-16, 3-17. (Note: Subsequent variants of this "basic" model will deal only with changes in Assumption #1, other assumptions remaining constant.)

(b) Spare parts, materials, equipment, and special facilities are available immediately unless noted otherwise.

(c) Travel times to, from, and between repair sites are not included.

(d) Time has been allowed for the field testing of each repaired item but not for testing the entire system following repair.

(e) The values given for repair effort do not include the time spent by supervisory personnel above the level of "foreman."

Repair Effort Overview

Incorporating the assumptions enumerated above, the repair effort associated with damage to the electric utility system from an overpressure of nine psi appears in Table 1.

It is immediately apparent from Table 1 that the total repair effort associated with damage to a single electric utility from nine psi overpressure would be substantial.

Using "boilermakers" as an example, the source cited in the URS study indicates that optimal configuration of a time-phased repair effort would involve the following sequence:

1. 250 shifts (36 men/shift)
2. 65 shifts (32 men/shift)
3. 45 shifts (20 men/shift)
4. 40 shifts (16 men/shift).

In terms of boilermaker repair time, the total of 400 shifts translates into 20 calendar months of effort (one 8-hour shift per day, 5-day week). During these 20 months, an average of 25 skilled boilermakers are required to render one isolated system operative.

Table 1*

Repair Effort for Typical Metropolitan Electric Utility System Damaged by Nine PSI Overpressure

System	Skill Classification	Man-days of Repair Effort
Generating Plant	Boilermaker	12,622
	Boilermaker Helper	11,400
	Carpenter	350
	Cement Worker	650
	Electrician	6,870
	Equipment Operator	2,650
	Rigger	2,650
	Iron Worker	910
	Millwright	4,160
	Pipe Fitter	1,960
	Steam Fitter	8,880
	Welder	6,640
Transmission System	Electrician	19,200
	Equipment Operator	10,600
	Rigger	10,600
	Linemen	23,000
Distribution System	Linemen	154,000
	Equipment Operator	22,000
	Total Man-days	299,142

*W. H. Van Horn, et al., op. cit., p. 6-6.

C. Variants of the Basic Repair Model: Implications for Labor Productivity of Changes in Work Intensity and Scheduling

Variants of Intensity and Scheduling

It is interesting to note how total repair time might be affected by changes in work intensity and work scheduling. A range of variants of the basic repair model appears in Table 2. Each of the 14 variants of the 8-hour, 1-shift, 5-day work-week schedule has implications for labor productivity.

Table 2

Total Repair Time as a Function of Varying Work Intensities and Scheduling

V	Hours/Shift	Shifts/Day	Days/Week	Total Repair Time (Months)
1	8	1	5	20.0
2	8	1	6	16.7
3	8	1	7	14.3
4	12	1	5	13.3
5	12	1	6	11.1
6	12	1	7	9.5
7	8	2	5	10.0
8	8	2	6	8.4
9	8	2	7	7.2
10	12	2	5	6.7
11	12	2	6	5.6
12	12	2	7	4.8
13	8	3	5	6.7
14	8	3	6	5.6
15	8	3	7	4.8

As is evident from Table 2, the total repair time varies rather significantly as a function of varying shift lengths, number of shifts per day, number of days per work-week, and combinations of these variables. The total repair time varies from a high of 20 months using the basic repair model (V=1) to a low of 4.8 months using either variant 12 or 15 (12-hour day, 2 shifts per day, 7-day work-week; and 8-hour day, 3 shifts per day, 7-day work-week, respectively).

However, there are two constraints associated with the repair effort variants--the skill constraint and the productivity constraint. The skill constraint is defined simply as an absolute shortage of requisite skills for the repair effort. The productivity constraint is defined as a labor productivity degradation associated with unfamiliar and stress-inducing work schedules; while less obvious, this is possibly more important in many situations. Both of these constraints, working separately or in combination, may condition the decision-maker's choice of repair strategies.

Productivity Constraints Identifiable with Repair Effort Variants

Table 3 summarizes, in quite general terms, the probable effects on labor productivity which would obtain under varying schedules of repair effort.

Table 3

Negative Effects on Boilermaker Productivity (Prolonged Repair Period)

V	None	Minimal	Serious	Very Serious
1, 7, 13	X			
2, 4, 8, 10, 14		X		
5, 11			X	
3, 6, 9, 12, 15				X

Interpreting Table 3, it is hypothesized that there would be no loss in labor productivity attributable to the work schedule itself for variants 7 and 13. These variants consist of highly familiar work schedules (8-hour shift, 5-day work-week). Exceptions to this general hypothesis might occur where multi-shift schedules are utilized, as is the case for both of these variants. In these cases, labor productivity might be adversely affected during some "adaptation" period, while workers previously unaccustomed to swing or night shifts adjust to different living schedules. It is not expected that productivity would suffer greatly as a result of these work-shift variables.

For variants [illegible], 4, 8, 10 and 14, it is reasonable to assume that labor productivity will be affected to some degree, but that any negative effects will be minimal, on the average. In the cases of variants 4 and 10, the work-day is increased to 12 hours, while the work-week remains at five days. For variants 2, 8 and 14, the work-week is lengthened to six days, while the work-day remains at 8 hours. Over a prolonged period, it is expected that both the longer-day and the longer-week effects will downgrade labor productivity to some extent. Again, the multi-shift "adaptation" effect might be operative, imposing an additional constraint on labor productivity for some period of time. It might be possible to determine empirically whether total hours per week or work scheduling is the more important variable. In this case, total production per worker might not exactly reflect the difference between the 48-hour work-week (variants 2, 8 and 14) and the 60-hour work-week (variants 4 and 10).

It is expected that utilization of repair variants 5 and 11 would produce serious negative effects on labor productivity over a prolonged repair period. Although total man-hours per week increase to 72, the "effective" man-hours might more nearly approach that of the worker who spends 60 hours a week on the job, as in variants 4 and 10. Variant 11 again introduces the "adaptation" effect on productivity, or at least the possibility of such an effect.

Variants 3, 6, 9, 12 and 15 all involve 7-day work-weeks which would, it is hypothesized, have very serious effects on labor productivity over a significant repair period. There would likely be variable effects among the different work

schedules composing this group. For instance, the 8-hour day variants (3, 9 and 15) would have less serious effects than the 12-hour day variants (6 and 12), which seem not to be feasible alternatives over any long period. The "adaptation" factor should again be operative in multi-shift schedules such as 9, 12 and 15.

The above variants of the basic repair model have important implications for labor productivity. Some of the negative consequences have been suggested; however, there are many other factors which condition worker performance beyond changes in hours per shift, time of shift, and length of work-week. The few variables discussed, however, serve to point to the fact that total output per worker may not display a direct relationship to total hours worked. Diminishing returns set in at some point when various unfamiliar combinations of work intensity and scheduling are introduced. On the other hand, there may well be instances of "increasing returns" which offset some of those negative effects. Such factors as postattack motivation, e.g., the "bounce-back effect," are examined in subsequent discussion.

A manager who is trying to develop a manpower allocation system for all organized effort in his community will be constrained by the available effort he can draw from various work groups. Equation 21 in the discussion of mathematization above, suggests that there are a number of factors outside of his control that would limit the amount of hourly effort per week he could assign workers. Solution of equation 21 could provide the basis for determining the best shift length and number of days' work per week that he could reasonably assign to men. We will assume that the quality of effort will drop drastically when work assignments exceed available effort as calculated by use of equation 21.

D. Labor Substitution Analysis for a Critical Skill Constraint: Implications for Labor Productivity

Introduction

The discussion above examined possible sources of labor productivity degradation stemming from the subjection of workers to unfamiliar and possible stress-inducing work intensities and schedules. The present section extends the

analysis to an examination of the manner in which labor productivity might be affected by the necessity for substituting among skills in the face of an absolute constraint in one occupation--boilermaker.

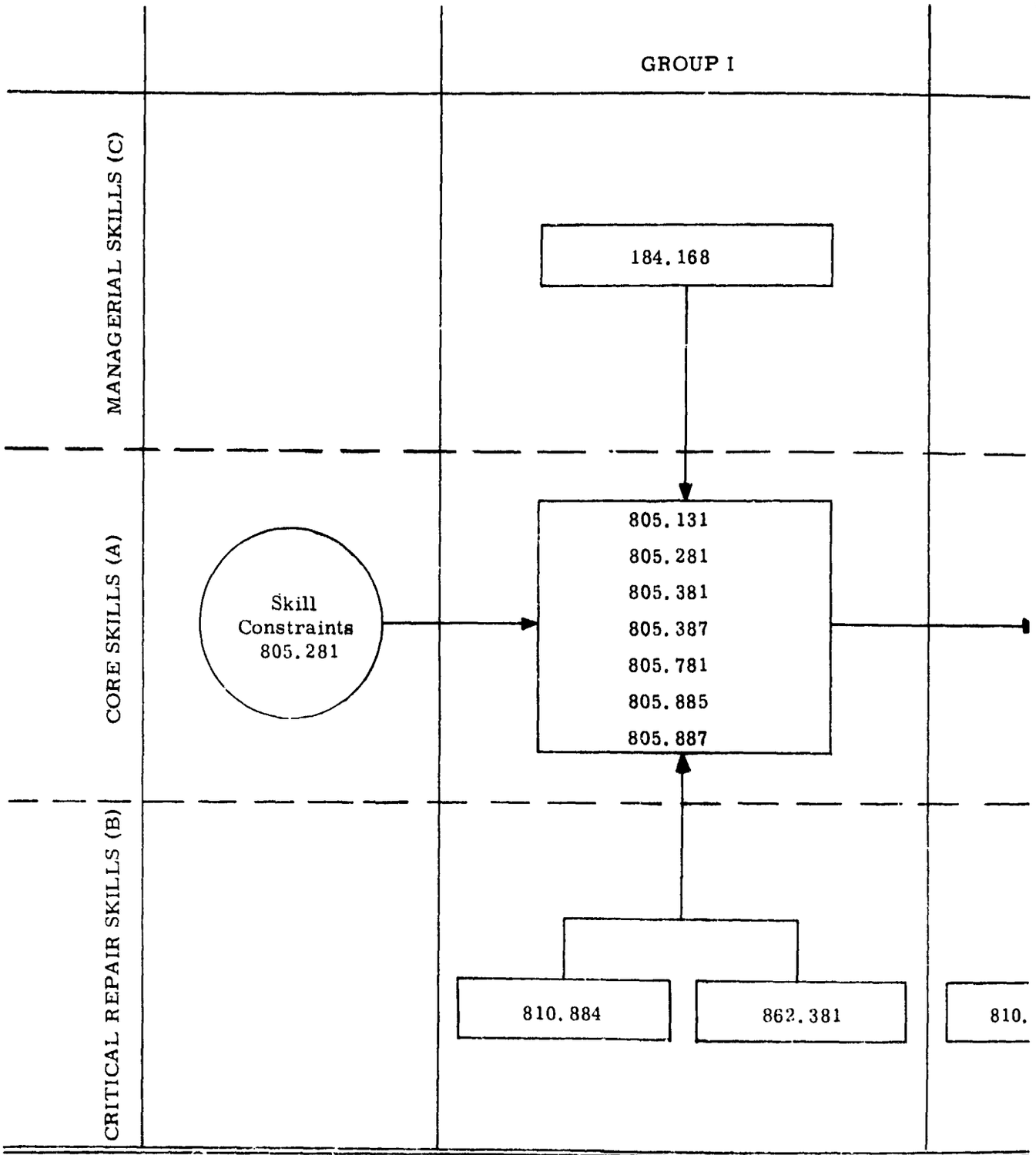
The conceptualized procedure for systematically substituting among labor skills emphasizes the managerial and informational requirements of the substitution tasks. For some of the reasons highlighted above, the postattack repair period will be characterized by considerable disorganization, and the manager's ability to successfully procure appropriate repair skills will depend to a great extent on his pre- and postattack information concerning the occupational and industrial structures of the area under consideration. The problem of the substitution of skills is not, then, merely a technical "interchangeability" problem; rather, it is one that involves the entire organizational configuration of the repair effort. The present analysis emphasizes this point by introducing labor organizational factors such as the "worker team" concept, which have important implications for labor productivity, and thus for the repair effort.

Labor Substitution Analysis for Critical Repair Skill Constraint

Figure 5 conceptualizes a procedure by which a manager might compensate for an absolute shortage of a particular skill by systematically substituting other available skills. The present analysis treats boilermakers as the skill constraint, and relates to the electric utility system described in Tab A; as well as the repair analysis above. The term "manager" is used to denote any decision-making unit charged with organization of the postattack repair effort of the utility system.

Along the left-hand border of Figure 5 are three skill categories: "Managerial Skills," "Core Skills," and "Critical Repair Skills."

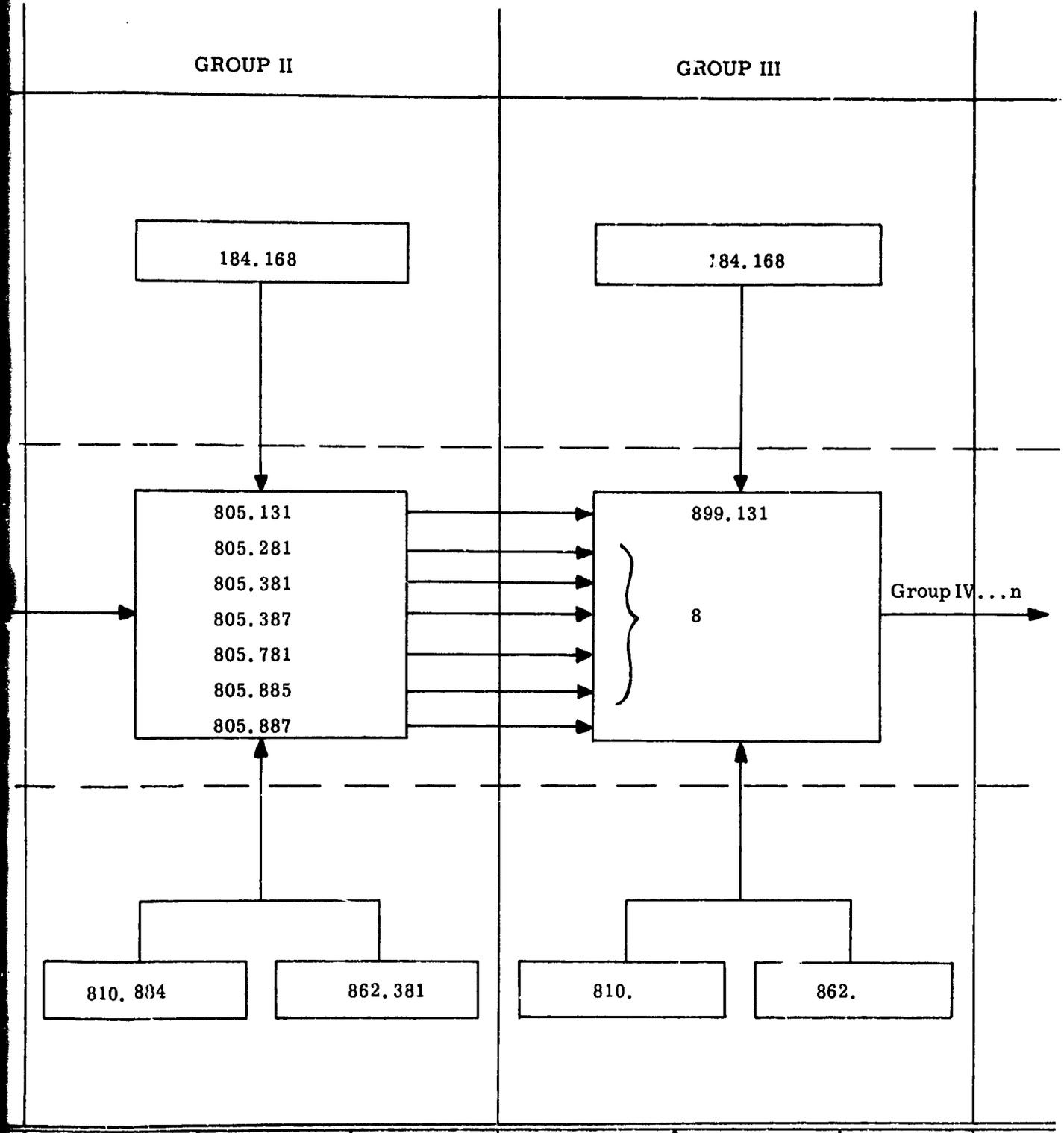
The Managerial Skills are largely self-explanatory. These skills are required for much the same reasons as they are required under preattack conditions. However, this group has been differentiated to emphasize the increased importance of the managerial function in the postattack environment.



Skills	Industry	S.I.C.	Skills
Managerial	Specific	491	Managerial
Core	Specific	491	Core
Critical Repair	Specific	491	Critical R

Figure 5.
Skill Substitution Protocol

1



Skills	Industry	S.I.C.	Skills	Industry	S.I.C.
Managerial	Specific	49	Managerial	Specific	49
Core	Non-Specific	Mfg., Constr., Trans., Comm., Pub. Util.	Core	Non-Specific	——
Critical Repair	Non-Specific	——	Critical Repair	Non-Specific	——

The Core Skills include those occupations grouped by the Dictionary of Occupational Titles[3] (hereafter termed Dictionary) under the designation "805. Boilermakers." These occupations are considered "core" in the sense of being highly complementary in function. The supportive function role of a "Boilermaker Helper," for instance, is apparent. It is desirable to retain as much of the normal functional structure of this core skills group as possible for maximum feasible labor productivity in the postattack environment. The importance of this concept is emphasized in the discussion of worker team formation.

The Critical Repair Skills are those required to augment repair skills which the boilermaker would be capable of exercising in his normal occupational role. The literature[4] indicates a need for significant numbers of specialized welders and steamfitters as support personnel to repair the boiler system of the electric utility's generating plant. Additional skill requirements include equipment operators and riggers; however, these occupations are not given special treatment here.

Along the upper border of Figure 5 are three Skills Groups (I, II, and III). These three groupings, taken together, approximate what might be termed a "labor productivity degradation continuum," proceeding from left to right. Each group is defined by the "skill distance" of component occupations from the optimal repair skills.

Along the lower border of Figure 5 is a summary of the industry-specificity component of the labor productivity degradation continuum. The industrial category from which the manager should attempt to procure the necessary skills is described for each Skills Group (I, II, and III). This aspect of the procedure is based on the proposition that substitute skills within the same industry or as close as possible to the industry under consideration are likely to achieve greater productivity in the repair task than those not closely related.

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[3] U.S. Department of Labor, Dictionary of Occupational Titles, 3rd edition, Vol. II, Occupational Classification (Washington, D.C.: U.S. Government Printing Office, 1965).

[4] W.H. Van Horn, et al., op. cit., p. A-34.

The analysis proceeds by means of a progression of "decision cells," as depicted in Figure 5--e.g., the first three decision cells consist of: Group I/Core Skills, Group I/Critical Repair Skills, and Group I/Managerial Skills.

Group I/Core Skills

Confronted with an absolute shortage of boilermaker repair capability, the manager must (1) procure additional appropriate (perfectly substitutable) boilermaker skills, and/or (2) procure and organize other skills which will produce a minimum of negative effects on over-all labor productivity and repair operations. The following tasks would be performed under the present procedure:

Determine the Functional Position of the Skill Constraint within the Occupational Structure

The functional position is determined by the first three digits of the skill under consideration. In this example, the functional position is defined by the digits "805" in the Dictionary:

> 8 - Structural Work Occupations:
> This category includes occupations concerned with fabricating, erecting, installing, paving, painting, repairing, and similarly working structures or structural parts, such as bridges, buildings, roads, motor vehicles, cables, airplane engines, girders, plates, and frames. The work generally occurs outside a factory or shop environment, except for factory production line occupations. Tools used are hand or portable power tools, and such materials as wood, metal, concrete, glass, and clay are involved. Workers are frequently required to have a knowledge of the materials with which they work, e.g., stresses, strains, durability, and resistance to weather.
>
> 80 - Occupations in Metal Fabricating, N.E.C.[5]:
> This division includes occupations concerned with fabricating, erecting, and repairing building frames and ornamental metalwork, bridges, trestles, marine

[5] N.E.C.: Not Elsewhere Classified.

craft and structures, boilers, storage tanks, drilling rigs, towers, and other structures generally assembled from heavy structural plates, beams, and castings; fitting and assembling vehicle bodies, airframes, prefabricated door casings and window frames, air ducts, and other structural shapes; and assembling or repairing boats, automobile bodies, and other structural units partially or entirely constructed of rigid plastics or fiber glass.

805 - Boilermakers:
This group includes occupations concerned with assembling, erecting, and repairing boilers and related equipment, attachments, and accessories. Includes laying out, cutting, fitting and bolting, welding, or riveting heavy metal plates, boiler tubes, and castings.

Determine the Occupations within the Occupational Group "805. Boilermakers"

As listed in the Dictionary, these occupations are:

805.131 - BOILERMAKER FOREMAN (boilermaking)

805.281 - BOILERMAKER (boilermaking) I

805.381 - BOILERHOUSE REPAIRMAN (any industry)

805.387 - BOILERHOUSE INSPECTOR (any industry)

805.781 - BOILERMAKER MECHANIC (boilermaking)

805.885 - BOILERMAKER HELPER (boilermaking) II

805.887 - BOILERMAKER HELPER (boilermaking) I

Determine the Relevant Industrial Designation from Which to Procure the Core Skills

The Standard Industrial Classification Manual[6] (hereafter termed S.I.C.) classifies industries and industry groups on a digital basis similar to the classification of occupations in the Dictionary. Proceeding on the basis that a manager should, if possible, procure additional boilermakers and support personnel from the industry or subindustry most closely related to the industry under consideration,

[6]U.S. Bureau of the Budget, Standard Industrial Classification Manual (Washington, D.C.: U.S. Government Printing Office, 1967).

he would then look to S.I.C. Industry Group No. 491--"Electric Companies and Systems" within his geographical constraint. (Note: The geographical constraint imposed on this analysis is defined by the limits of the metropolitan area described in Tab A.)

In summary, the occupational group defined by the Dictionary designation "805. Boilermakers," and the industrial designation defined by S.I.C. Industry Group No. 491--"Electric Companies and Systems," combine to delimit the GroupI/Core Skills decision cell. In effect, the optimal labor substitutes for skilled boilermakers, consisting of equally skilled boilermakers or some number of support personnel within the "805" group, would be procured from other electric utilities in the metropolitan area under consideration. It is expected that labor productivity would, on the average, be degraded only slightly in the first substitution phase (Group I), if the manager is successful in procuring the required number of personnel in the "805" core skills group.

Group I/Critical Repair Skills

As mentioned above, "critical repair skills" are those indicated as necessary supplements to the boilermaker's capabilities and which, in the postattack period, would relieve the boilermaker of some of his normal (preattack) repair tasks.

The critical repair skills are also drawn from the Dictionary's occupational category "8--Structural Work Occupations," which is defined above. In the case of specialized welders, the manager determines the effective supply of "810.884--Boilermaker Welder (boilermaking) from the occupational division "81--Welders, Flame Cutters, and Related Occupations," and the occupational group "810--Arc Welders." In the case of steamfitters, the manager determines the availability of "862.381--Pipe Fitter (const.) I" from the occupational division "86--Construction Occupations, Not Elsewhere Classified," and the occupational group "862--Plumbers, Gas Fitters, Steam Fitters, and Related Occupations."

As in the procurement of core skills in Group I, it is important that the critical repair skills be obtained, if possible, from S.I.C. Industry Group No.

491--"Electric Companies and Systems." Such a procedure ensures maximum worker familiarity with electric utilities repair, and decreases possible negative effects on labor productivity stemming from the necessity for orientation and, perhaps, special training.

Group I/Managerial Skills

The managerial function will be of particularly critical importance in the postattack repair phase. The Dictionary designation "184.168--Superintendent, Generation (light, heat, and power) is the most appropriate category from which to procure managers in Group I. This designation is contained within the occupational category "1--Professional, Technical, and Managerial Occupations"; the occupational division "18--Managers and Officials, Not Elsewhere Classified"; and the occupational group "184--Transportation, Communication, and Utilities Industry Managers and Officials."

As in the cases of the Core Skills and Critical Repair Skills, the managerial requirements should be met, to the extent possible, by procuring personnel from the elctric utilities themselves; e.g., from S.I.C. Industry Group No. 491--"Electric Companies and Systems."

Two types of managerial skills have been identified under Group I: "Superintendent, Generation (light, heat, and power)" and "Boilermaker Foreman (boilermaking)." The functional differentiation between these occupations is indicated by the last three digits of their classifications; .168 and .131, respectively. Both occupations require the highest degree of skill in relation to Data. (Note: See Tab B for definition of the last three digits in the Dictionary's occupational coding system.) In the case of People and Things (fifth and sixth digits), the Boilermaker Foreman ranks higher. This designation is interpreted to mean that the Boilermaker Foreman is the key position for effectively organizing the Core Skills team and integrating the supplementary Critical Repair Skills for the repair task. The Generation Superintendent, on the other hand, is responsible for the overall system functioning. Both skills are essential under normal circumstances, but become extremely critical in the postattack environment.

Summary--Group I

The Group I decision cells (A, B, C) depict a procedure by which a manager procures the required complement of skills to repair the boiler system of an electric utility. The procedure does not entail extensive skill substitution at this stage, if sufficient numbers of Core, Critical Repair, and Managerial skills are available from the appropriate industry designation.

There are at least potential management problems associated with the formation of worker teams within the Core Skills group, as well as with the integration of the Critical Repair Skills into the worker teams. The redefinition and reallocation of tasks will pose problems for management, even in the event that sufficient skills are procured. Group I most closely approximates the ideal situation for the manager, wherein he is relatively successful in procuring the necessary repair skills. [Note: The boundaries between groups (e.g., between Group I and Group II) are depicted as being identical for each Skill Group for illustrative purposes only. It will be apparent that the manager will encounter problems in procuring particular skills before others, in which case he would follow the procedure outlined in successive groups (II, III, ...n).]

Group II/Core Skills

Group II/Core Skills, as depicted in Figure 5, consist of those comprising Group I/Core Skills. Group II is premised, however, on the inability of the manager to procure the requisite skills under Group I; e.g., the manager has exhausted the "805. Boilermaker" skills available within the constraint of S.I.C. Industry Group No. 491--"Electric Companies and Systems."

As indicated along the lower border of Figure 5, the Core Skills are no longer associated with any particular industrial designation but with several broad industry categories. Whereas the Group II decision process would attempt to preserve the functional team defined by the 805 occupational group, the skills represented by those occupations would be procured from industries other than that most closely related to the industry under consideration.

For example, the U.S. Census of Population[7] indicates that there were slightly more than 23,000 boilermakers in the 1960 national labor force. A manager can obtain a first approximation of the distribution of a particular skill among industries in a particular area, such as a city, by rough knowledge of the national distribution of that skill, combined with a knowledge of the industrial base of the area under consideration. For instance, the Census indicates that slightly more than 20,000 of the 23,000 boilermakers nationally were employed in Manufacturing Construction, Transportation, Communication, and Public Utilities in 1960. Within Manufacturing, the durable goods industries accounted for 10,139 boilermakers, while the nondurable goods industries employed 3,727. Within the Transportation, Communication, and Public Utilities industry group, Transportation Industries accounted for approximately 2,450 boilermakers; the Utilities and Sanitary Services Industry group employed slightly more than 800. Proceeding on this basis, the manager can approximate the preattack boilermaker capability in a particular area. Most of the 10,134 boilermakers involved in durable goods industries are probably employees of firms that manufacture boilers. The manager would know that the availability of boilermakers should be good if such firms exist in his community and not so good if they do not. More precise methods should be used to estimate potential pools of critical skills in particular areas; however, all methods require a significant informational input to complement the managerial function. The importance of information becomes particularly critical beyond Group I, when skills must be procured from industries which are not necessarily closely related to the utility system under consideration.

It is expected that labor productivity will, on the average, be degraded by the necessity for recruiting boilermakers and related skills from other industries. On the other hand, preattack productivity levels will be more closely approached to the extent that the functional team aspects of the repair effort can be preserved, regardless of the specific source of substitute skills.

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[7] U.S. Bureau of the Census, PC(2)-7C, U.S. Census of Population: 1960, Subject Reports, Occupation by Industry (Washington, D.C.: U.S. Government Printing Office, 1963).

Group II/Critical Repair Skills

As in the case of Group II/Core Skills, Critical Repair Skills should be procured with a view toward preserving the specialized knowledge of the occupation. In this example, the welders and pipefitters should be knowledgeable in the repair of vessels and other equipment designed to withstand extremes of pressure. The preattack distribution of these skills among industries should be approximated in a manner similar to that used for the Core Skills in Group II. Labor productivity will be degraded to the extent that workers with Critical Repair Skills must familiarize themselves with specific electric utility repair functions before they can become fully effective.

Group II/Managerial Skills

The managerial function increases in importance along the productivity degradation continuum, with the necessity for organizing an increasingly heterogeneous pool of labor skills into functioning worker teams. For this reason, managerial skills must continue to be drawn from those industries that are rather closely related to the electric utility under consideration. The ability to successfully organize such teams will be a function of the manager's familiarity with the specific industry in question, rather than possession of generalized managerial skills. Although the present analysis does not treat the possibility of importing skills from outside the limits of the imposed geographic constraint, the managerial function would be a likely candidate for a wide-ranging recruiting effort, if such skills were in short supply. In this example, the procedure calls for the recruitment of managers from the S.I.C. Major Industry Group 49--"Electric, Gas, and Sanitary Services."

Summary Group II

Group II is characterized by increased informational and managerial functions. Informational needs are intensified by the necessity to procure skills from diverse industrial sources. Managerial needs increase because of this diversity of skill sources. The repair operation is characterized by some labor

which is effective in a particular context, but which may require certain orientation and training prior to achieving or approximating full preattack productivity in the new situation.

Group III/Core Skills

In contrast to Groups I and II Group III is characterized, at least potentially, by significant dissolution of the functional work team as defined by the occupational group "805. Boilermakers." The manager will have exhausted all or a major portion of the component "805" skills at his disposal. In this and succeeding phases, the success of the repair effort will, in large part, be a function of the occupational information available to the decision-maker; whereas in previous phases the informational requirements were mainly industrial in nature. The family of arrows leading from Group II indicates the process of analyzing individual occupations in terms of skill requirements in order to ascertain the most appropriate substitute skills.

Although not demonstrated in Figure 5, it would be possible, using the Dictionary's detailed occupational definitions, to develop indices of minimum skill requirements for each occupation. Knowledge of the occupational requirements would, in turn, constitute criteria for selection and procurement of additional repair skills. For example, the occupation "899.131--Labor Crew Foreman (const.; light, heat, and power) has been substituted for "805.131--Boilermaker Foreman." This occupation is classified within the occupational group "899.--Miscellaneous Structural Work Occupations, N.E.C." As indicated by the last three digits "131," the basic requirements of the occupation in terms of Data, People, and Things are identical. However, it is expected that the Labor-Crew Foreman would be less familiar with specific aspects of boilermaking and repair, and consequently, less "productive" in the repair task than the more appropriate skill.

In like manner, each of the Core Group Skills can be analyzed in terms of their minimum requirements. The designation "8" which encompases the remaining core occupations indicates that the manager would initially confine his skill

substitution efforts within the Dictionary's occupational category "Structural Work Occupations."

Group III/Critical Repair Skills

Critical Repair Skills of the specialized nature most suitable to repair of a boiler system will have been exhausted in this phase. The manager would seek to procure additional welders in the occupational group "810.--Arc Welders," and additional pipefitters in the occupational group "862.--Plumbers, Gas Fitters, Steam Fitters, and Related Occupations." Both skills might be considerably downgraded as a result of the substitution process, since the requirements of the tasks are highly specialized. Welders and pipefitters who are inexperienced, to one extent or another, in the repair of pressure vessels must gain or upgrade their skills through on-the-job training, which, in turn, is labor-consuming. Productivity is likely to improve after this "learning period," although it is not likely that this category of worker will achieve productivity levels equal to the most appropriate skills.

Group III/ Managerial Skills

As indicated along the lower border of Figure 5, the managerial function continues to be industry-specific; and, for reasons cited above, increases in importance in succeeding groups along the continuum. To the extent that highly appropriate managerial skills cannot be obtained, worker disorganization is likely to degrade labor productivity considerably in this phase, since worker teams are composed of workers with quite heterogeneous skills and backgrounds.

E. Summary

The conceptualized labor substitution procedure outlined above is one method, using existing data sources, whereby a manager can construct contingency plans for manpower utilization. The "problem" of postattack manpower utilization will involve more than a knowledge of occupational skills; it also involves a

familiarity with occupational and industrial structures in the area under consideration. The degree to which a manager is aware of potential pools of variously skilled labor, and the degree to which he perceives the relationships among various occupations, will determine the effectiveness of manpower utilization in the postattack repair situation.

The procedure is presented in outline form only; however, it could be demonstrated that, for a particular geographic area, such a technique is operational from an informational standpoint, using largely existing data sources. More detailed analysis could be performed to ascertain, or at least approximate the effects on labor productivity of "skill distance" in highly critical occupations--e.g., those which are believed to be indispensable for any repair of any abnormal magnitude. The actual postattack configuration of skill availability among industries cannot be ascertained before the fact, but the technique could be designed so as to provide contingency plans for alternative states of the universe. Such a contingency plan for skill substitution can become the basis for full consideration of the effects of social and psychological factors on postattack productivity.

The discussion above deals with the question of how much effective repair effort of one particular type is needed to repair one crucial linkage in the production network. If the team sizes indicated in the URS study are optimal [a simplifying assumption], then any reduction in the effectiveness of a man hour of effort due to skill substitution cannot be compensated for by adding more men. In high skill operations this will often be true. Thus any decrease in effectiveness of applied effort can only lengthen the time required to repair this link. A protocol for assigning a value to the skill substitution factor (Y) can be developed for each group of Figure 5. For Group I, the factor would be one (1) and for each subsequent group it would be lower. The component of the communication factor (C_1) that deals with communications within the work group would be reduced as recruitment of workmen was forced to move from the categories of Group I to categories of Group II, Group III, etc. Depending on whether or not the workmen recruited were teams that had formerly worked together, this communication factor might be further reduced.

We presume that a rough analysis of the surviving population in terms of equation 3 has suggested how many man hours of work per week it is reasonable to expect of workmen. Some rough analysis of the available work force and their skill levels will suggest how many shifts can be utilized. These factors taken together will suggest which work intensity schedule can be picked from Table 3. The work intensity schedule reveals what the total repair time in months would be if these hours of effort were performed at a preattack effectiveness level. The coefficients for motivation (Z), communication (C) and skill substitution (Y) can be applied directly to the ideal total repair time to determine what the actual total repair time is likely to be.

In the instance where leisure was almost completely given up by workmen, where transportation time had not increased, a 72-hour work week is achievable. It is close to the upper limit. Two 12-hour shifts, six days a week would yield such a manpower utilization. Ample manpower might permit an equivalent expenditure of effort spread among three 8-hour shifts working six days a week. In either event, ideal total repair time would be 5.6 months.

If the composite effects on motivation yield, for the work group under consideration, a motivation factor (Z) of 0.9; if the composite effects on communication yield a communication factor (C) of 0.9; if the composite effects of skill substitution yield a skill substitution factor of 0.9; the actual total repair time can be expected to be $(\frac{5.6}{.729})$ or 7.7 months. The figures used above are optimistic for a postattack metropolitan area. Adjustments can be made as information is available in the actual situation.

The above calculation shows at least this: In calculating the time required to repair one link in a metropolitan area's production network, neglect of social and psychological factors could very easily yield results 37-1/2 percent in error. The most probable error is considerably higher. Any effort to use a network analysis approach to the determination of economic recovery will be seriously distorted if social and psychological factors are not considered. Considering the length of time required to reestablish a basic linkage such as electrical power generation and its probable effect on productivity, an input-output analysis of postattack productivity instead of a network analysis appears to be even more unrealistic.

TAB A

Metropolitan Electric Utility System: Typical Configuration

Metropolitan Electric Utility System: Typical Configuration

An electric utility system designed to serve a large metro-area (population of 400,000; area of 100 square miles) typically consists of three major component systems: generation, transmission, and distribution.

1. Generation System

The generation system typically includes the following subsystems:

a. Coal Handling Subsystem--Consists of a pulverized coal system with a rotary car dumper and a covered coal conveying system. These are assumed to be located outside the generating plant building, with the coal pulverizer inside. Capacity is 120 tons/hour.

b. Boiler Subsystem--The boiler is of the controlled forced-circulation type, is rated at 2,400,000 lbs. of steam at 2,700 psi, and contains an air heater, economizer, and superheating stages. Both the boiler and its ancillary equipment are located inside a large, reinforced concrete, steel-framed building. All ducts, flues, and piping are located inside the building, with forced-draft fans located outside next to the stack.

c. Cooling Water Subsystem--Cooling is provided by a body of water (lake, river, ocean) rather than by cooling towers. The water intakes, traveling trash screens, and pumps are located at the water's edge in a light, concrete building. The condenser and hot-well pumps are located inside the generating plant building, under the turbine; reheaters are outside.

d. Turbo-Generator Subsystem--the turbo-generator set is a 330-MW tandem compound, four-flow type with exciter, station bus, control cubicles, and 350-MVA generator transformer. All units except the transformer are located inside the generator building. A 30-psi hydrogen system provides cooling for the generator. Forced-feed lubrication of the turbo-generator set is provided by an oil pump.

2. Transmission System

Free-standing 110kV steel transmission towers are arranged in a network system. Substations are also included in this system and consist of four single-phase, step-down transformers (three in use and one standby) with four circuit breakers and appropriate bus structures (five disconnects per transformer). The transmission system is comprised of 80 circuit miles of transmission line (ring plus partial network), of which 40 miles are 110 kV, 20 miles are 69 kV, and 20 miles are 34 kV.

3. Distribution System

Free-standing wooden utility poles carry 12-kV, with ten 50-kVA transformers per circuit mile of distribution. (One 12-kV circuit consists of three bare conductors; insulated conductors are commonly used only in underground service or in low voltage and service to consumers.) The distribution system is comprised of 28 substations (4 single-phase transformers each). Eight substations transform 110 kV to 12-kV; ten substations transform 69-kV to 12-kV; and ten substations transform 34-kV to 12-kV. The distribution system is also comprised of 980 circuit miles of 12-kV line, serving 160,000 residential services, 13,000 commercial services, 1,000 light industrial services, and 120 heavy industrial services.

TAB B

Dictionary of Occupational Titles*
(Third Edition, 1965)

*Information contained in this Appendix is distilled from U.S. Bureau of Employment Security, Dictionary of Occupational Titles (Third Edition), Volume I, Definitions of Titles and Volume II, Occupational Classifications.

Dictionary of Occupational Titles
(Third Edition, 1965)

The occupations in the Dictionary have been incorporated into a classification structure in which the individual occupations are identified by six-digit code numbers. The structure consists of two arrangements of jobs--the Occupational Group Arrangement and the Worker Traits Arrangement. These provide (1) a method of grouping jobs having the same basic occupational or worker trait characteristics so that the user can discern various relationships among the occupations, and (2) a standard approach to classifying the abilities, vocational experiences, and/or potentials of workers.

Occupational Group Arrangement

Throughout this arrangement, jobs are grouped according to a combination of work field, purpose, material, product, subject matter, service, generic term, and/or industry, as reflected in the first three digits of the code. All occupations are grouped into nine broad categories, which, in turn, are divided into divisions and then groups.

The nine occupational categories of the occupational group arrangement are identified by the numbers 0-9, reflected in the first digit of the code number, as follows:

0, 1 } Professional, technical, and managerial occupations
2 Clerical and sales occupations
3 Service occupations
4 Farming, fishery, forestry, and related occupations
5 Processing occupations
6 Machine trades occupations
7 Bench work occupations
8 Structural work occupations
9 Miscellaneous occupations

The categories are divided into 84 two-digit divisions and the divisions, in turn, are subdivided into 603 distinctive three-digit groups....

In Category 0 and 1 (Professional, Technical, and Managerial Occupations), most two-digit divisions are based on broad subject matter areas (e.g., Occupations in Social Sciences). The three-digit groups 001 through 169 are based on more specific subject matter identifications (e.g., 050. Occupations in Economics), while groups 180 through 189 identify managerial work subdivided according to economic activities (e.g., 181. Mining Industry Managers and Officials).

In Category 2 (Clerical and Sales Occupations), the clerical divisions are based on type of activity (e.g., 20 Stenography, Typing, Filing, and Related Occupations), and the three digit groups on more specific types of activity (e.g., 214. Billing-Machine Operators). The sales divisions distinguish among three types of three-digit groups; those based on services sold (e.g., 254. Salesmen, Hotel Services), commodities sold (e.g., 274. Salesmen and Sales Persons, House Furnishings), and sales techniques (e.g., 294. Auctioneers).

In Category 3 (Service Occupations), the divisions are based on type of service rendered (e.g., 37 Protective Service Occupations), and the three-digit groups on generic terms (e.g., 307. Nursemaids) or more specific types of service (e.g., 361. Laundering Occupations).

In Category 4 (Farming, Fishery, Forestry, and Related Occupations), the divisions and groups are based primarily on products (e.g., 40 Plant Farming Occupations; 401. Grain Farming Occupations) or type of activity (e.g., 45 Hunting, Trapping, and Related Occupations; 422. Farm Irrigation Workers).

The Categories 5 through 8 (Processing Occupations, Machine Trades Occupations, Bench Work Occupations, and Structural Work Occupations) encompass broad areas of work as they occur in industry, and their titles are derived from trade terminology. The criteria for establishing divisions are primarily work fields (e.g., 65 Printing Occupations), materials (e.g., 50 Occupations in Processing of Metal), or products (e.g., 72 Occupations in Assembly and Repair of Electrical Equipment). The three-digit groups are based on more specific work fields (e.g., 552. Distilling Occupations), materials (e.g., 669. Wood Machining Occupations), or products (e.g., 788. Occupations in Fabrication and

Repair of Footwear), and in many instances generic terms are used (e.g., 785. Tailors and Dressmakers).

Most of the divisions and groups in Category 9 (Miscellaneous Occupations) relate to nonmanufacturing economic activities (e.g., 91 Transportation Occupations, N.E.C.; 912. Air Transportation Occupations).

The last three digits of the (Dictionary of Occupational Titles) code numbers are based on the following findings of U.S. Employment Service Research:

1. Every job requires the worker to function in relation to Data, People, and Things, in varying degrees.
2. The relationships specific to Data, People, and Things can be arranged in each case from the simple to the complex in the form of a hierarchy so that, generally, each successive function can include the simpler ones and exclude the more complex functions. (Note: As each relationship to People represents a wide range of complexity resulting in considerable overlap among relationships, their arrangement is somewhat arbitrary and can be considered a hierarchy only in the most general sense.)
3. It is possible to express a job's relationship to Data, People, and Things by identifying the highest appropriate function in each hierarchy to which the job requires the worker to have a significant relationship.
4. Together, the last three digits of the code number can express the total level of complexity at which the job requires the worker to function.

The hierarchies are:

DATA (4th digit)	PEOPLE (5th digit)	THINGS (6th digit
0 Synthesizing	0 Mentoring	0 Setting-Up
1 Coordinating	1 Negotiating	1 Precision-Working
2 Analyzing	2 Instructing	2 Operating-Controlling
3 Compiling	3 Supervising	3 Driving-Operating
4 Computing	4 Diverting	4 Manipulating
5 Copying	5 Persuading	5 Tending
6 Comparing	6 Speaking-Signaling	6 Feeding-Offbearing
7 No signif. relat.*	7 Serving	7 Handling
8	8 No signif. relat.*	8 No signif. relat.*

*The numeral 8 signifies that the relationship which the job requires of the worker is not significant within a particular hierarchy. Whenever a worker's involvement in the Things hierarchy is at the 0, 1, or 2 level, and there is not significant relationship to Data, the digit 7 is used in the Data hierarchy instead of the digit 8.

APPENDIX B

ROOTS OF THE MODEL: THE CONCEPTUAL BASIS

ROOTS OF THE MODEL: THE CONCEPTUAL BASIS

The sources of insights that a scientist depends upon are never entirely accessible to his conscious analysis. If he is well read in his field, many, many contributors to the field have influenced his thinking and contributed to his ability to formulate theory and hypotheses. We cannot, therefore, identify all major contributors to this presentation. However, we can suggest some of the main streams of thought and the key thinkers to whom we know we are indebted.

First on the list must be one of the founders of modern sociology, Émile Durkheim. His concept of society as "separate" is the foundation concept for our treating society as a system. His concept of social currents as being manifest in and running through different societies in consequence of their mode of organization (developed most explicitly in Suicide),[1] is a point of reference for this analyis. The concept of society as "separate" or as a system is also derived from some of the discussions of scientific methodology by Talcott Parsons.

Second in our order of listing must be the work and thought of Adolph Lowe. Professor Lowe stands as the interpreter through whose eyes we have seen the contributions of the classical economists, the Marxists, particularly Karl Marx himself, and the modern systems economists whom we conceive of as deriving from the basic works of Lord Keynes. Modern systems economists suggest that the economic processes can be considered a system of relationships where coefficients and time constraints can be used in a fashion similar to that used in the analysis of physical systems. The problem associated with this analysis, which Professor Lowe particularly perceived, is that these coefficients are derivatives of values and beliefs. These values and beliefs extend beyond the frame of reference of traditional economics.

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[1] Émile Durkheim. Suicide. Translated by John R. Spaulding and George Simpson (Glencoe, Ill.: The Free Press, 1951).

Our debt to Professor Wassily Leontief is obvious in our frequent references to input-output analysis. However, we perceive this type of relationship in terms of flow rates rather than in tabular accounting form. We are particularly indebted to the now-forgotten economist who first conceived of economic process as a counterflow with goods and services flowing in one direction and money flowing in the other.

Basic background assumptions underlying this analysis derive from the social psychology of George H. Mead. We conceive of Mead's analysis of how personality emerges in, and at the same time contributes to, social process as being tentatively definitive. The society that we treat as analytically separable from individuals is nevertheless conceived to be a manifestation of the ongoing processes of interaction suggested by Mead's theory. When we discuss the beliefs and expectations that people in various groups have, the persistence of these beliefs and the behavioral regularities which result from these beliefs, we are assuming that these beliefs emerge in the processes of socialization that Mead describes; we are assuming that they are sustained when these processes are persistent and that they weaken when these social processes weaken. It is the disappearance of some important social processes and reference symbols after a crisis that is crucial for societal change and adjustment following crisis.

Mead's analysis of personality development cannot be considered as complete, however. Mead gives little attention to the fundamental desires, needs, or drives of men which are more adequately attended to in the works of Freud. We find that we must include consideration of "needs" when we examine situations where social processes that support a prior shared belief system are changing.

When we turn our attention to governmental processes in developing our model, the insights provided by Max Weber in developing his typologies of legitimate order--traditional, legal-rational, and charismatic--have significance for us. Our concept of units that constitute the governmental subsystem is suggested by Weber's concepts of staff within each order and enlarged by more recent thought about formal and informal structure in organizations. The question of sustaining legitimacy, as noted by Weber, becomes an important point of reference in

considering how the participatory democratic, legal-rational, system of ours can best be sustained through disaster and recovery.

Last in our list of references for our underlying assumptions is the literature on social stratification. Studies such as those of Warner and Hollingshead are particularly relevant sources of insight and theory. Kahl's book on The American Class Structure[2] summarizes much of the class and status research that has served as source material.

In addition to being a social scientist, the primary author of the model is an engineer. He spent many years designing and developing servomechanism controls, and servomechanism theory has thus influenced the form of this model development.

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[2]Joseph A. Kahl. The American Class Structure (New York: Rinehart and Company, 1953).

APPENDIX C
BIBLIOGRAPHY

BIBLIOGRAPHY

Representative Source Works in Social Science

Allpert, Floyd H. "The J Curve Hypothesis of Conforming Behavior" Journal of Social Psychology, Vol. V (1934), pp. 141-183.

Durkheim, Emile. The Rules of Sociological Method. Translated by S. A. Solovay and J. H. Mueller. Glencoe, Ill.: The Free Press, 1938.

_____. Suicide. Translated by John R. Spaulding and George Simpson. Glencoe, Ill.: The Free Press, 1938.

Kahl, Joseph A. The American Class Structure. New York: Rinehart and Company, 1953.

Keynes, John Maynard. The General Theory of Employment, Interest and Money. New York: Harcourt, Brace and Co., 1936.

Leontief, Wassily. Input-Output Economics. Oxford: Oxford University Press, 1966.

Lowe, Adolph. On Economic Knowledge. New York: Harper and Row, 1965.

Mead, George H. Man, Self and Society. Chicago, Ill.: The University of Chicago Press, 1934.

Weber, Max. The Theory of Social and Economic Organization. Translated by A. M. Henderson and Talcott Parsons. Glencoe, Ill.: The Free Press, 1947.

Representative Recent Research Reports from the OCD Dialogue

"Institutional Factors in Total Vulnerability," Francis W. Dresch and Hazel B. Ellis. Menlo Park, Calif.: Stanford Research Institute, April 1968. (Contract No. OCD-PS-64-201)

"A Model of Technological Capacity to Support Survivors of Nuclear Attack," Bernard Sobin. McLean, Va.: Research Analysis Corporation, September 1968. (Contract No. DAHC20-67-C-0137)

"Nuclear Blast Effects on a Metropolitan Economy," William C. Truppner. Arlington, Va.: Institute for Defense Analyses, September 1965. (Contract No. OCD-OS-63-134)

"Scenario for Postattack Social Reorganization," Raymond D. Gastil. Croton-on-Hudson, N.Y.: Hudson Institute, Inc., August 1969. (Contract No. DAHC20-68-0142)

"Civil Defense Research Analysis," John F. Devaney. Washington, D.C.: Research Directorate, Office of Civil Defense, November 1967.

Research and Analysis on Social and Psychological Aspects of Disasters

Barton, Allen H. Social Organization under Stress: A Sociological Review of Disaster Studies, Disaster Study Number 17. Washington, D.C.: National Academy of Sciences--National Research Council, 1963.

De Hoyos, Arturo. "The Tampico Disaster." Unpublished report, Social Research Service, Department of Sociology and Anthropology, Michigan State University, 1956.

Form, William H. and Sigmund Nosow. Community in Disaster. New York: Harper and Brothers, Publishers, 1958.

Fritz, Charles E. and Eli S. Marks, "The NORC Studies of Human Behavior in Disaster," The Journal of Social Issues, 10, 12-25, 1954.

Glasstone, Samuel (ed.). The Effects of Nuclear Weapons, revised edition. Washington, D.C.: U.S. Department of Defense, 1962.

Hersey, John. Hiroshima. New York: Alfred A. Knopf, 1946.

Iklé, Fred Charles. The Social Impact of Bomb Destruction. Norman, Okla.: University of Oklahoma Press, 1958.

Janis, Irving L. Air War and Emotional Stress: Psychological Studies of Bombing and Civilian Defense. Santa Monica, Calif.: The RAND Corporation, 1951.

_____. "Psychodynamic Aspects of Stress Tolerance." Presented at a conference on "Self-Control under Stressful Situation," under auspices of the Bureau of Social Science Research, Inc., Washington, D.C., on September 9-10, 1962, under Contract AF 49(638)-992 OSR-USAF.

Marks, Eli S. and Charles E. Fritz. "Human Reactions in Disaster Situations." Chicago, Ill.: National Opinion Research Center, University of Chicago, 1954.

Stoddard, Ellwyn R. Conceptual Models of Human Behavior in Disaster, Social Science Series, No. 1. El Paso, Texas: The University of Texas at El Paso, 1968.

Titmuss, Richard M. Problems of Social Policy. London: His Majesty's Stationery Office and Longmans, Green and Co., 1950.

Wenger, Dennis E. and Arnold R. Parr. Community Functions under Disaster Conditions, Disaster Research Center Report Series, No. 4. Columbus, Ohio: Ohio State University, 1969.

White, Meda Miller. "Role-Conflict in Disasters: Not Family But Familiarity First." A Research Report submitted to the Disaster Study Group, National Academy of Sciences--National Research Council--Unpublished. The University of Chicago, 1962.

Reference Works for Appendix A

Brown, Stephen L. "Industrial Recovery Techniques." Menlo Park, Calif.: Stanford Research Institute, April 1966.

_____. "Occupational Skills and Civil Defense." Menlo Park, Calif.: Stanford Research Institute, September 1966.

Pendleton, William W. "A Study of Personnel Demands and Availabilities for Postattack Countermeasure Systems," McLean, Va.: Human Sciences Research, Inc., June 1966.

Snyder, Monroe B., and Alfred J. Farina. "Methods and Techniques for Postattack Manpower Utilization." McLean, Va.: Human Sciences Research, Inc., August 1967.

U.S. Bureau of the Budget. Standard Industrial Classification Manual. Washington, D.C.: U.S. Government Printing Office, 1967.

U.S. Department of Commerce, The Bureau of the Census. Census of Population (1960), Subject Report PC(2)-7C, Occupation by Industry. Washington, D.C.: U.S. Government Printing Office, 1963.

U.S. Department of Labor, Bureau of Employment Security. Dictionary of Occupational Titles, Third Edition, Vol. I, Definitions of Titles and Vol. II, Occupational Classification. Washington, D.C.: U.S. Government Printing Office, 1965.

Van Horn, William H., Gail B. Boyd, and Carl R. Foget. "Repair and Reclamation of Gas and Electric Utility Systems." Burlingame, Calif.: URS Corporation, July 1967. (Prepared for Stanford Research Institute)

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A model of society has been developed. It identifies key social and psychological factors that are crucial for societal system functioning. The model of society is described in conceptual, diagrammatic and equation form. The analysis provides a first order quantitative estimate of values of some key social and psychological factors. This permits the incorporation of social and psychological factors in systems analysis of society in crisis. An illustrative example of such an analysis is presented. Conclusions regarding the importance of social and psychological factors in crisis and recovery situations are drawn. An appendix dealing with the human element problems of repair of a particular key power plant damaged by nuclear attack is presented.

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Sociometrics						
Societal Vulnerability						
Societal Effects of Nuclear Attack						
Social Systems						
Society						
Civil Defense						
Civil Defense Systems Evaluation						
Crisis, Disaster, Recovery						
Social Structure						
Sociology						
Skill Substitution						